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Instructions: W0010038

Product: EV starting motor
Part no.: 0 001 223 ..

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Continue: A01

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Continue: IV26/1

SPECIAL FEATURES

These instructions describe repair procedures for the following preengaged-drive starting motors of type EV

- 12 V/2.3 kW	0 001 223 0..
- 12 V/2.6 kW	0 001 223 5..

Continue: I02/2

SPECIAL FEATURES

Use is always to be made of a new parts set on assembly.

The water drain sockets are also to be renewed.

Lubricate in line with lubrication schedule before and during assembly.

Prior to assembly, use three-square scraper to remove all residual lacquer on fitting and sealing surfaces.

Continue: I03/1

SPECIAL FEATURES

After assembly, the starting motor is to be sealed with nitrocellulose combination lacquer (5 899 607 017).

Continue: I03/2

SPECIAL FEATURES

The overrunning-clutch drive is subject to a high level of wear and is always to be replaced.

Always renew bushing in commutator end shield and needle bushing in drive-end bearing.

The entire planetary gear train is to be replaced if its drive shaft is damaged or impermissibly worn.

Continue: I04/1

SPECIAL FEATURES

Starting motors of this type feature different designs of brush holder, distinguished for example by the geometric shape of the bracket for the excitation winding connection. This does not however affect testing and replacement of the brush holder.

Starting motors of this type have different planetary gear train versions with 3 or 4 planet gears. This does not however affect testing.

Continue: I04/2

SPECIAL FEATURES

There is no form of solenoid switch testing which can provide reliable information on trouble-free operation over a long period.
It is therefore also advisable to renew the solenoid switch when repairing the starting motor.

Continue: I01/1

STRUCTURE, USAGE

PC user prompting:
Position cursor on button and confirm.
Microcard user prompting:
User prompting is provided on every page e.g.:
- Continue: I 17/1
- Continue: II 18/1 Fig.: II 17/2

Brief instructions may include several rows of coordinates.
I../. = first coordinate row
II../. = second coordinate row
III../. = third coordinate row
etc.

.../1 = upper coordinate half
.../2 = lower coordinate half

Continue: I01/1

GENERAL

Unless otherwise stated, the voltages indicated in these instructions are DC voltages.
AC voltages are marked by the symbol " * ".

Continue: I06/2

GENERAL

Expert repairs are only possible using the prescribed tools and measuring instruments, which are in perfect working order. We therefore recommend that exclusive use be made of the tools listed.

The use of incorrect and unsuitable tools and testers can lead to injury and may damage the product concerned or its component parts.

Continue: I07/1

GENERAL

Some of the tools listed in these repair instructions were originally developed for a different application.

The appropriate instructions are to be heeded when using these tools.

Continue: I07/2

GENERAL

Only use replacement parts given in the service parts list for the starting motor concerned.

Proper functioning presupposes use of the lubricants specified in these instructions, both prior to and during assembly.

Absolute cleanliness is to be ensured when performing repair work.

Continue: I01/1

SAFETY MEASURES

Component cleaning:
Armature, excitation windings, commutator end shield, relay and overrunning-clutch drive are only to be cleaned using compressed air (max. 4 bar) and a clean cloth. Use is never to be made of liquid cleaning agents.

Other components such as planetary gear train and drive-end bearing can be washed out in a commercially available cleaning agent which is not readily flammable. Take care never to inhale vapors. Components must be re-lubricated or re-greased in line with the lubrication schedule.

Continue: I08/2

SAFETY MEASURES

Danger of fire: Take care to avoid naked flames and sparking.

ATTENTION:
Make sure parts which have been cleaned are thoroughly dried, as gases subsequently forming in the sealed starting motor can lead to an explosion.

Always use the listed tools. Injuries cannot be precluded if use is made of incorrect and unsuitable tools and testers.

Continue: I09/1

SAFETY MEASURES

Always heed the following safety regulations:

* German Order governing the use of flammable liquids (VbF).
* Accident prevention regulations for electrical systems and equipment.
* Safety regulations for the handling of chlorinated hydrocarbons:
  - For companies: ZH 1/222
  - For employees: ZH 1/129

  issued by the German industrial liability insurance associations (central association for accident prevention and industrial medicine), Langwartweg 103, 53129 Bonn.

Continue: I09/2

SAFETY MEASURES

Outside Germany, pay attention to appropriate local regulations.

Skin protection:
To avoid skin irritation when handling oil and grease, apply hand cream before starting work and wash cream off when finished with soap and water.

Continue: I01/1

TESTERS, EQUIPMENT, TOOLS

All tools required for repairing starting motors of type EV are listed in the following.

Some of the tools needed have to be improvised in line with the drawings.

The type designation is given in parentheses for tools which used to be ordered on this basis.

Continue: I10/2

TESTERS, FIXTURES, TOOLS

Interturn short-circuit tester with test probes:	0 986 619 110
Test prods:	0 986 619 101
(Old version:	0 986 619 114)
Alternator tester WPG 012.00:	0 684 201 200
(alternatively, Motortester)	
Magnetic measurement stand:	4 851 601 124
Dial indicator:	1 687 233 011
Mandrel press:	comm. avail.

Continue: I11/1

TESTERS, FIXTURES, TOOLS

Clamping support:	0 986 619 362 (KDAW 9999)
Torque wrench (0...70 Nm):	comm. avail.
Torquemeter (0.15...0.80 Nm):	0 986 617 206 (KDAL 5485)
Spring balance (2...12 N):	0 986 619 181 (KDAW 9991)

Continue: I11/2

TESTERS, FIXTURES, TOOLS

Disassembly sleeve/ stop ring:	0 986 617 114 (KDAL 5029)
Assembly sleeve/ stop ring:	0 986 617 113 (KDAL 5028)
Holder:	0 986 617 215 (KDAL 5487)

Continue: I12/1

TESTERS, FIXTURES, TOOLS

Circlip pliers:	comm. avail.
Flat-nose pliers:	comm. avail.
Gripping pliers:	comm. avail.
Hacksaw:	comm. avail.
Tailstock steady with Morse taper 2 for clamping diameter 5...45 mm for holding purposes when turning down armature:	0 986 619 156 (KDAW 9987)

Continue: I12/2

TESTERS, FIXTURES, TOOLS

Flat file:	comm. avail.
Vernier caliper:	comm. avail.
Three-square scraper:	comm. avail.
Column drill:	comm. avail.
Machine vice:	comm. avail.
HSS drill bit 4,3 mm:	comm. avail.

Continue: I13/1

TESTERS, FIXTURES, TOOLS

Bushing extractor:	0 986 617 243 (KDAL 5493)
Spring collet for bushings Diameter 12.5 mm:	0 986 617 246 (KDAL 5493/0/3)
Spring collet for bushings Diameter 10 mm:	0 986 617 250 (KDAL 5493/0/7)

Continue: I13/2

TESTERS, FIXTURES, TOOLS

Locating sleeve/ brush holder:	0 986 618 162 (KDLJ 6044)
Pressing-in mandrel:	0 986 617 149 (KDAL 5058)
Pressing-in mandrel with locating sleeve:	0 986 617 212 (KDAL 5486)

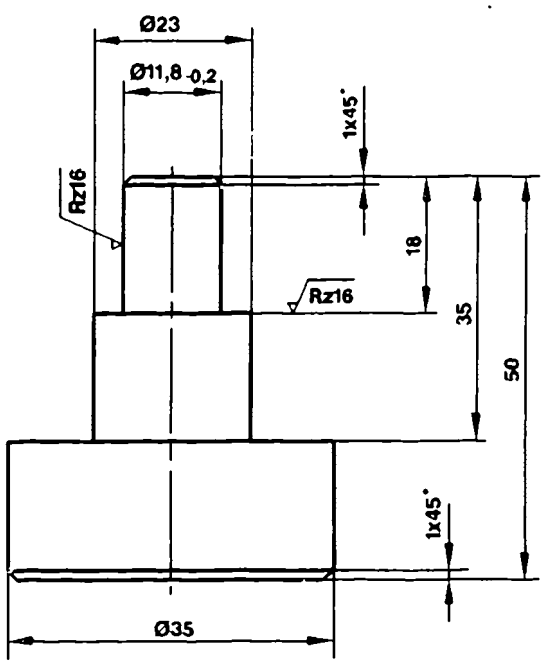
Continue: I14/1

TESTERS, FIXTURES, TOOLS

Pressing-in mandrel for needle bushing in drive-end bearing: improvised

Continue: I15/1 Fig.: I14/2

KMS00392



$\sqrt{Rz63}$ $(\sqrt{Rz16})$

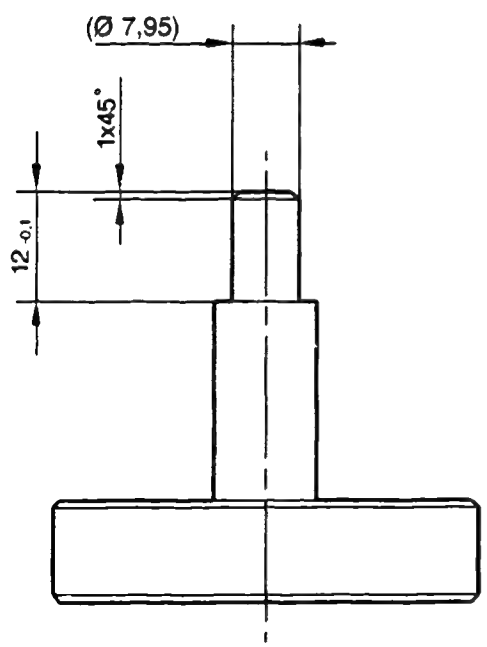
TESTERS, EQUIPMENT, TOOLS

Assembly stand for
planetary gear train: 0 986 617 138
(KDAL 5047)
(reworked version)

ATTENTION:
The 7.95 mm dia. pin at the assembly stand must be shortened to the dimension stated on the drawing.

Continue: I01/1 Fig.: I15/2

KMS00289



TEST SPECIFICATIONS AND SETTINGS

Commutator - minimum diameter:	29 mm
Eccentricity - Commutator:	< 0,01 mm
Armature axial clearance:	0,2...0,8 mm
Total pinion travel a:	10,5...15 mm
Armature braking torque:	0,8...1,5 Nm
Wear dimension x of carbon brushes:	< 15 mm

Continue: I16/2

TEST SPECIFICATIONS AND SETTINGS

Overrunning-clutch torque
Starting motor:

- 0 001 223 001: 0,42...0,50 Nm
- 0 001 223 002: 0,42...0,50 Nm
- 0 001 223 003: 0,27...0,35 Nm
- 0 001 223 004: 0,27...0,35 Nm
- 0 001 223 005: 0,14...0,22 Nm
- 0 001 223 5..: 0,35...0,65 Nm

Continue: I17/1

TEST SPECIFICATIONS AND SETTINGS

Solenoid switch energization voltage
12 V starting motor: 5...8 V

Solenoid switch resistance values

Pull-in winding:
Starting motor:
- 0 001 223 0..: 0,25...0,30 Ohm
- 0 001 223 5..: 0,20...0,25 Ohm

Continue: I17/2

TEST SPECIFICATIONS AND SETTINGS

Solenoid switch resistance values

Holding winding:
Starting motor
- 0 001 223 0..: 1,1...1,3 Ohm
- 0 001 223 5..: 1,0...1,1 Ohm

Continue: I01/1

TIGHTENING TORQUES

Attachment of commutator end shield and drive-end bearing:	5,5...6,0 Nm
Relay attachment:	4,5...5,5 Nm
Connection, brush holder, term. 30-f:	7,0...9,0 Nm
Connection, excitation winding, brush holder:	3,3...4,1 Nm
Connection term. 30:	12,0...15,0 Nm
Connection term. 50:	5,0...7,0 Nm

Continue: I01/1

LUBRICANTS/LUBRICATION SCHEDULE

General:

Commutator and carbon brushes are to be kept free of grease and oil.

Greased parts are to be degreased before re-lubricating them.

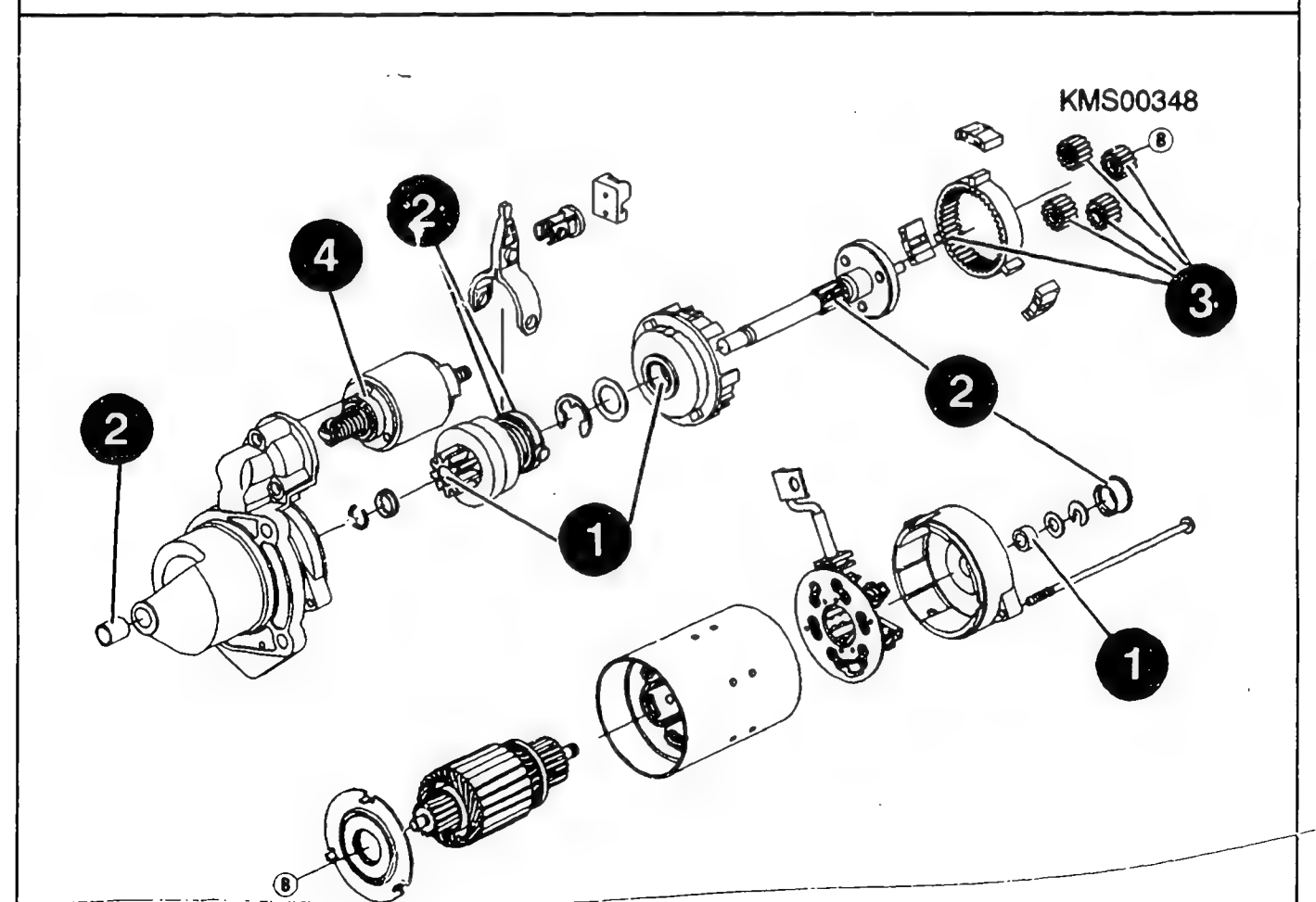
New bushings must be moistened prior to installation using suitable oil.
Oil VS 13 834-01: 5 962 260 000

Continue: I20/1

LUBRICANTS/LUBRICATION SCHEDULE

1	=	Oil VS 13834-Öl	5 962 260 000
2	=	Grease VS 10832-Ft	5 932 240 000
3	=	Grease VS 16069-Ft	5 984 610 120
4	=	Gleitmo 1580 V	5 996 328 000

Continue: I01/1 Fig.: I20/2

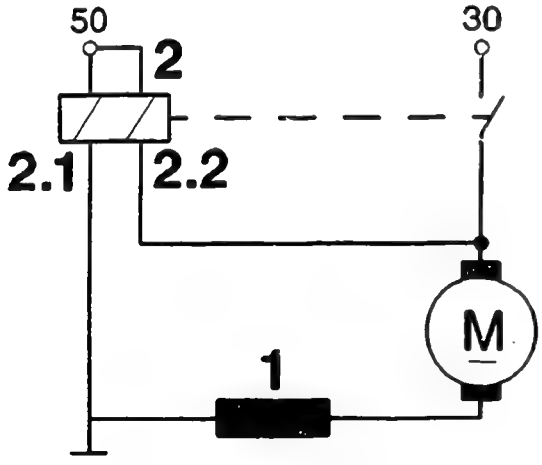


CIRCUIT DIAGRAM

1 = Excitation winding
2 = Solenoid switch
2.1 = Holding winding
2.2 = Pull-in winding

Continue: I01/1 Fig.: I21/2

KMS00291



STARTING MOTOR DISASSEMBLY TABLE

Disassembling solenoid switch	I23/1
Disassembling drive-end bearing	I26/1
Disassembling overrunning-clutch drive and planetary gear train	I28/1
Disassembling commutator end shield	II01/1
Disassembling armature	II03/1
Disassembling overrunning-clutch drive	II05/1

Continue: I01/1

STARTING-MOTOR DISASSEMBLY

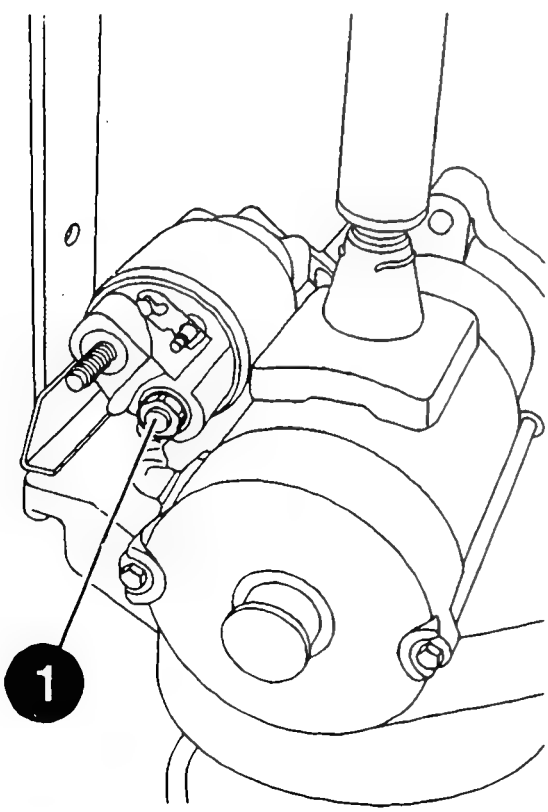
Solenoid-switch disassembly

Clamp starting motor in clamping support. Unfasten connection (1) of excitation winding at solenoid switch.

Clamping support: 0 986 619 362

Continue: I24/1 Fig.: I23/2

KMS00347



STARTING-MOTOR DISASSEMBLY

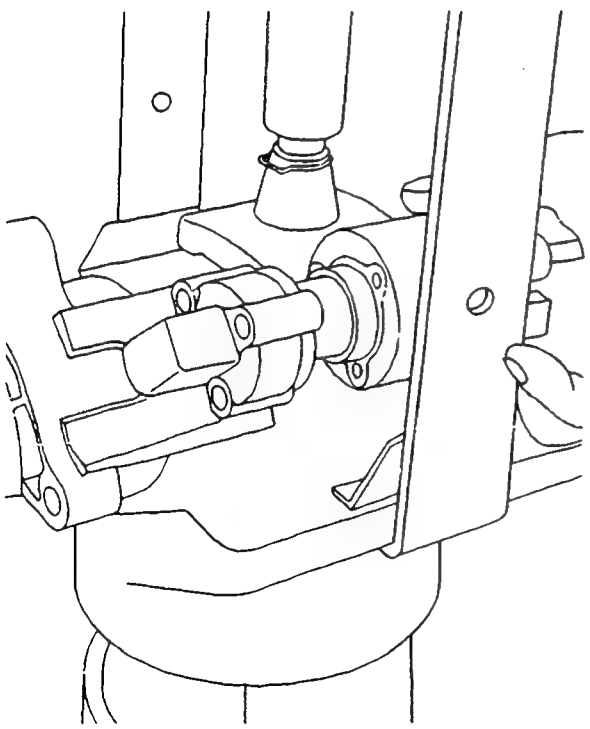
Solenoid-switch disassembly

Mark position of solenoid switch.
Unfasten relay screws.
ATTENTION: DANGER OF INJURY
The pretensioned return spring causes the solenoid switch to be pressed down by the relay armature.
Pull relay off relay armature.

Torx T25 bit: comm. avail.

Continue: I25/1 Fig.: I24/2

KMS00349



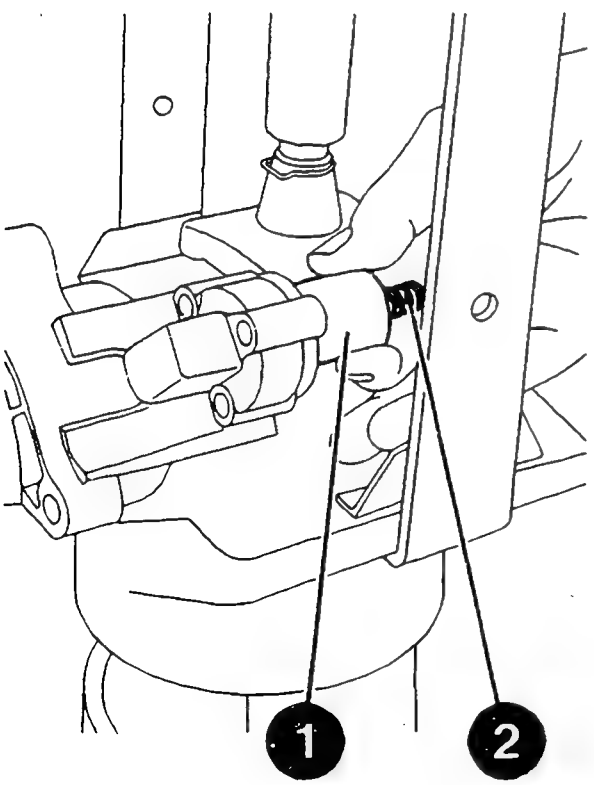
STARTING MOTOR DISASSEMBLY

Disassembling solenoid switch

Disengage relay armature (1) at fork lever.
Pay attention to return spring (2) in relay armature.

Continue: I22/1 Fig.: I25/2

KMS00350

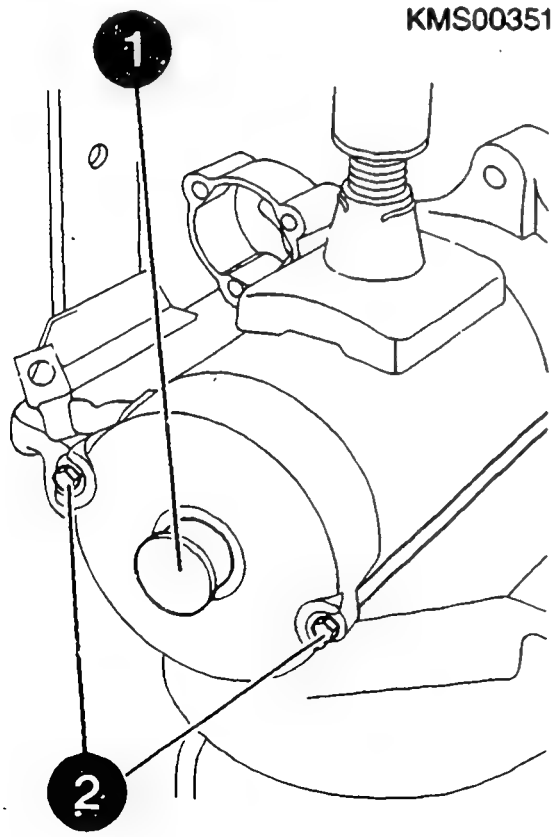


STARTING MOTOR DISASSEMBLY

Disassembling drive-end bearing

Prise cap (1) off commutator end shield.
Mark installation position of drive-end bearing and commutator end shield with respect to stator frame.
Slacken off bolts (2).

Continue: I27/1 Fig.: I26/2



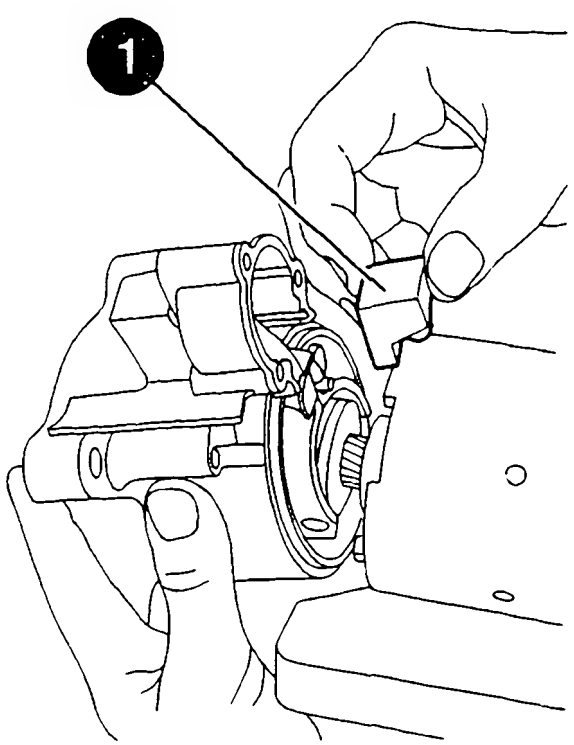
STARTING MOTOR DISASSEMBLY

Disassembling drive-end bearing

Detach drive-end bearing from stator frame; in doing so remove rubber seal (1) at bearing pedestal of fork lever.

Continue: I22/1 Fig.: I27/2

KMS00352



STARTING MOTOR DISASSEMBLY

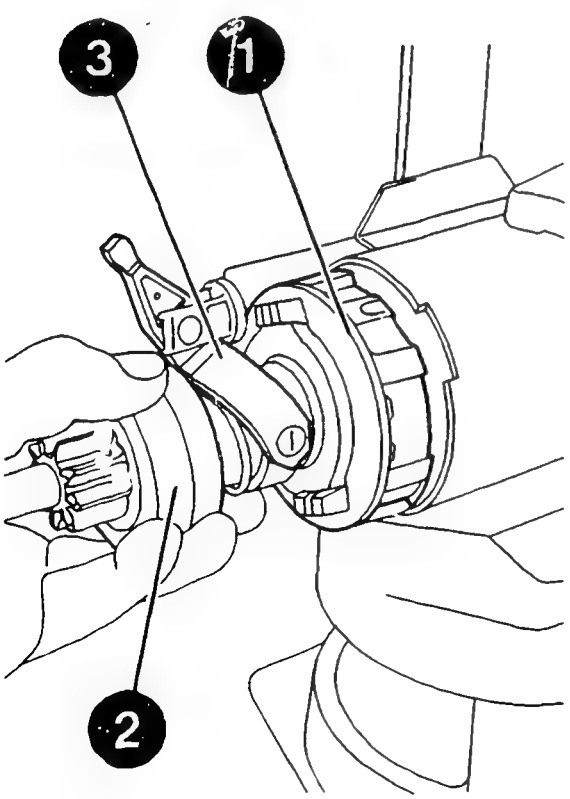
Disassembling overrunning-clutch drive and planetary gear train

Pull planetary gear train (1) with overrunning-clutch drive (2) and fork lever (3) out of stator frame.
NOTE: Planetary gear train may stick in stator frame if lacquer has ingressed.
Slip assembly horizontally onto stand and position vertically so as to avoid damage.

Assembly stand for planetary gear train (reworked): 0 986 617 138

Continue: I22/1 Fig.: I28/2

KMS00353



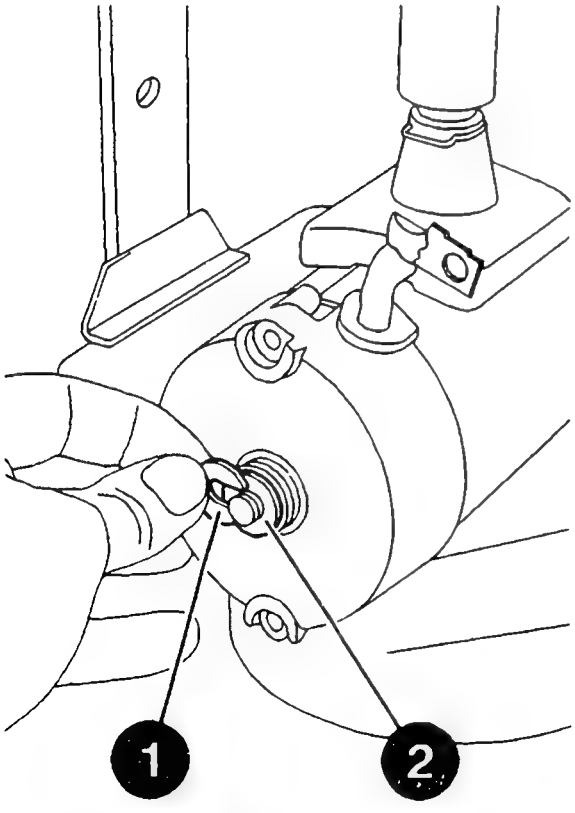
STARTING MOTOR DISASSEMBLY

Disassembling commutator end shield

Detach retaining collar (1) of armature shaft and shim (2).
NOTE: In the event of burr at the armature shaft groove, this is to be removed first, using for example a whetstone.

Continue: II02/1 Fig.: II01/2

KMS00354

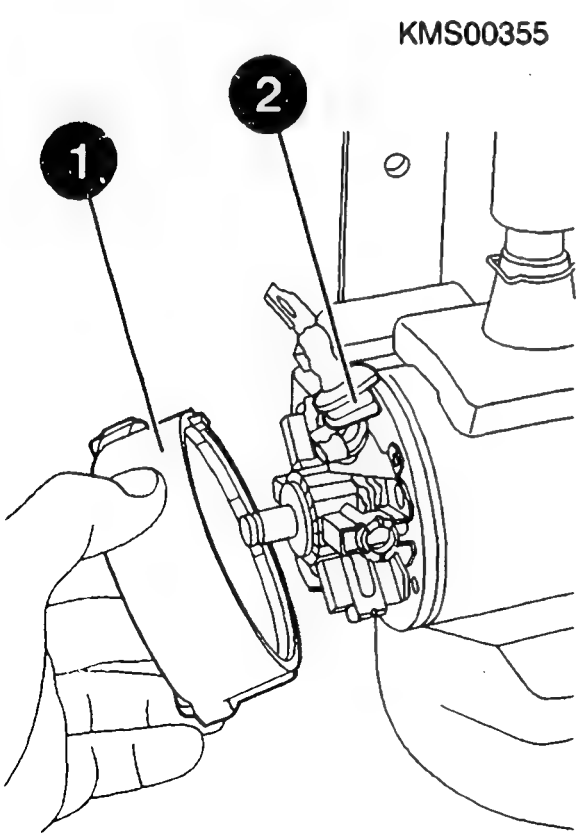


STARTING MOTOR DISASSEMBLY

Disassembling commutator end shield

Detach commutator end shield (1) from stator frame, taking care not to damage gasket (2).

Continue: I22/1 Fig.: II02/2



STARTING MOTOR DISASSEMBLY

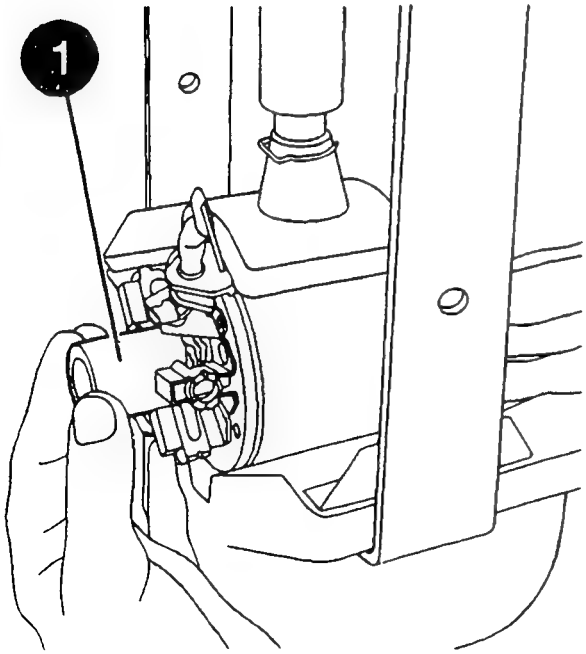
Disassembling armature

Attach locating sleeve (1) to armature shaft from commutator end.
ATTENTION: Make sure thread in locating sleeve does not damage armature shaft.

Locating sleeve: 0 986 618 162

Continue: II04/1 Fig.: II03/2

KMS00356



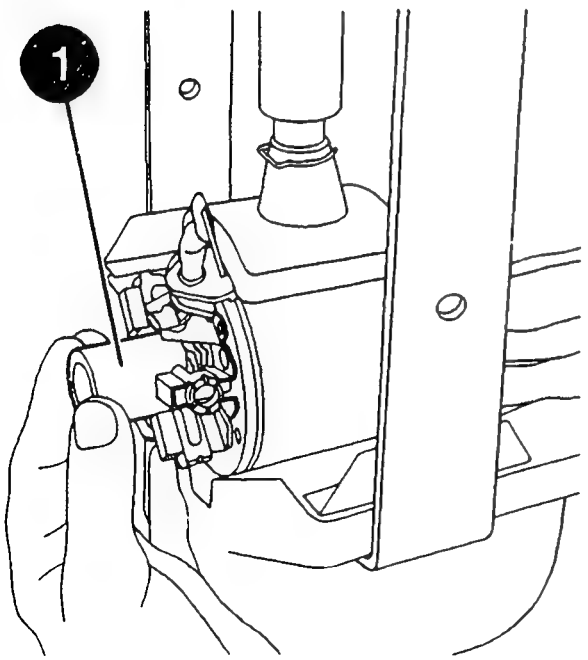
STARTING MOTOR DISASSEMBLY

Disassembling armature

Press armature out of stator frame to drive-end bearing side and in doing so insert locating sleeve (1) in brush holder.
The carbon brushes must rest on the tool.
ATTENTION: Take care not to damage excitation winding.

Continue: I22/1 Fig.: II04/2

KMS00356



STARTING MOTOR DISASSEMBLY

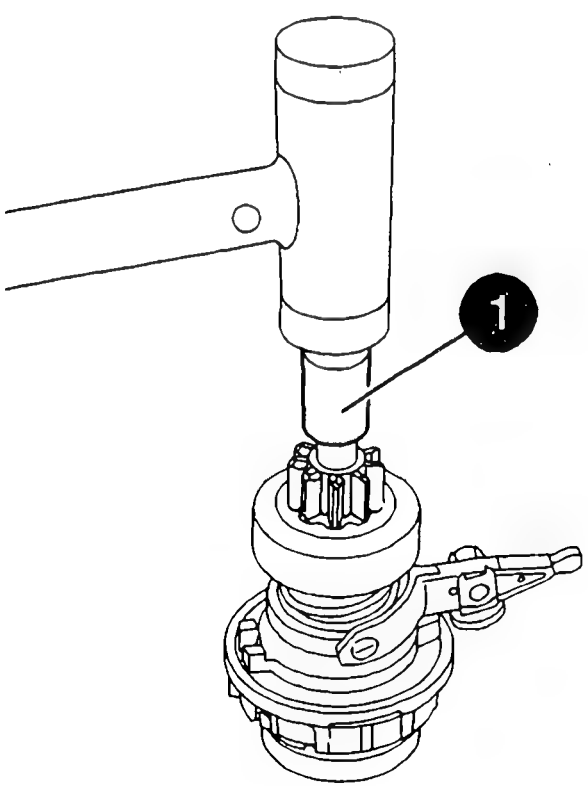
Disassembling overrunning-clutch drive

Attach disassembly sleeve (1) to drive shaft such that collar of sleeve is facing upwards.
Tap firmly (plastic-headed hammer) on assembly sleeve to knock back stop ring.

Disassembly sleeve/
stop ring: 0 986 617 114

Continue: II06/1 Fig.: II05/2

KMS00357



STARTING MOTOR DISASSEMBLY

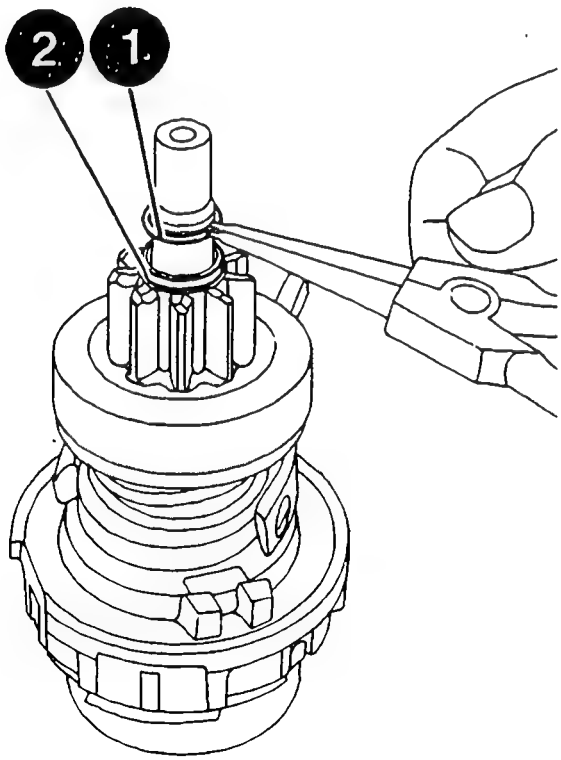
Disassembling overrunning-clutch drive

Bend open circlip (1) with pliers and detach from drive shaft.
Take care not to damage drive shaft when doing so.
Detach stop ring (2) from drive shaft.
NOTE: In the event of burr at the drive shaft groove, this is to be removed first using, for example, a whetstone.

Circlip pliers: comm. avail.

Continue: II07/1 Fig.: II06/2

KMS00358



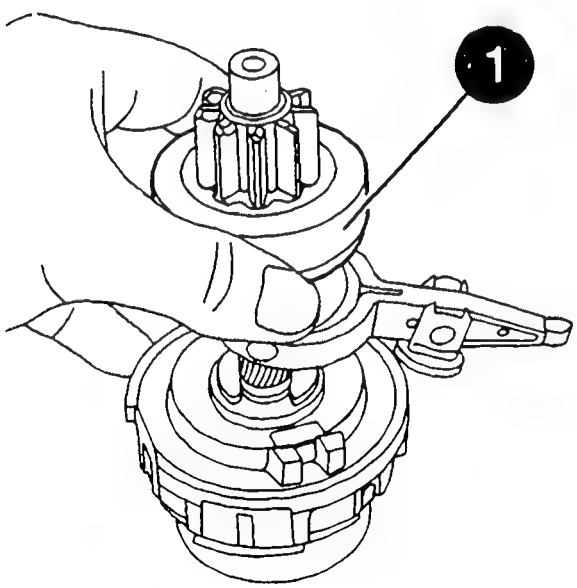
STARTING MOTOR DISASSEMBLY

Disassembling overrunning-clutch drive

Pull overrunning-clutch drive (1) with fork lever off drive shaft.

Continue: I22/1 Fig.: II07/2

KMS00359



COMPONENT CLEANING

Component cleaning:
Armature, excitation windings, commutator end shield, relay and overrunning-clutch drive are only to be cleaned using compressed air (max. 4 bar) and a clean cloth. Use is never to be made of liquid cleaning agents.

Other components such as planetary gear train and drive-end bearing can be washed out in a commercially available cleaning agent which is not readily flammable. Take care never to inhale vapors. Components must be re-lubricated or re-greased in line with the lubrication schedule.

Continue: II08/2

COMPONENT CLEANING

Danger of fire: Take care to avoid naked flames and sparking.

ATTENTION:
Make sure parts which have been cleaned are thoroughly dried, as gases subsequently forming in the sealed starting motor can lead to an explosion.

Continue: II09/1

COMPONENT CLEANING

Always heed the following safety regulations:

* German Order governing the use of flammable liquids (VbF).
* Accident prevention regulations for electrical systems and equipment.
* Safety regulations for the handling of chlorinated hydrocarbons:
  - For companies: ZH 1/222
  - For employees: ZH 1/129

  issued by the German industrial liability insurance associations (central association for accident prevention and industrial medicine), Langwartweg 103, 53129 Bonn.

Continue: II09/2

COMPONENT CLEANING

Outside Germany, pay attention to appropriate local regulations.

Skin protection:
To avoid skin irritation when handling oil and grease, apply hand cream before starting work and wash cream off when finished with soap and water.

Continue: I01/1

TESTING, REPAIR TABLE

Checking pinion	II11/1
Checking drive-end bearing	II12/1
Checking commutator end shield	II14/1
Replacing overrunning-clutch drive	II16/1
Checking planetary gear train	II18/1
Checking armature	II26/1
Checking commutator	III01/1
Checking brush holder	III04/1

Continue: II10/2

TESTING, REPAIR TABLE

Replacing brush holder	III07/1
Checking excitation winding	III19/1
Checking solenoid switch	III21/1

Continue: I01/1

COMPONENT TESTING AND REPAIR

Testing pinion

Meshing pinion and overruning-clutch drive are subject to considerable wear. Overruning-clutch drive is therefore always to be replaced.

Continue: II10/1

COMPONENT CHECKING AND REPAIR

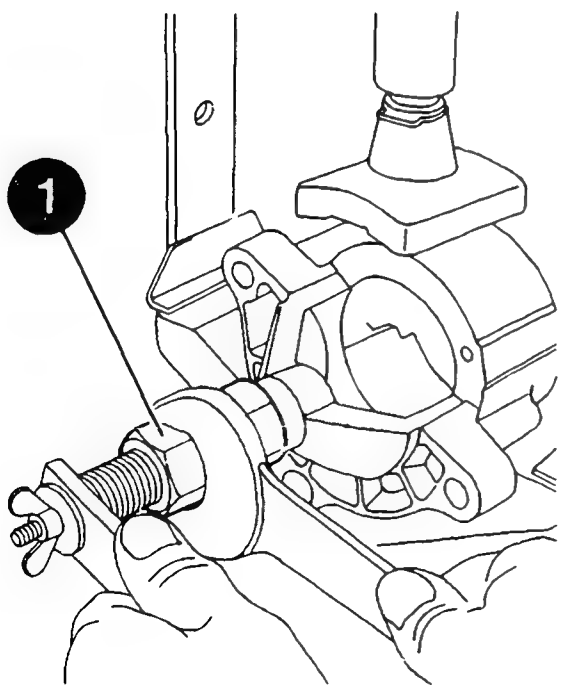
Checking drive-end bearing

Needle bushing of drive-end bearing is always to be replaced.
Removal: Mount drive-end bearing in clamping support. Use puller (1) and spring collet to extract needle bushing from drive-end bearing.

Clamping support:	0 986 619 362
Puller:	0 986 617 243
Spring collet diameter 12.5 mm:	0 986 617 246

Continue: II13/1 Fig.: II12/2

KMS00360



COMPONENT CHECKING AND REPAIR

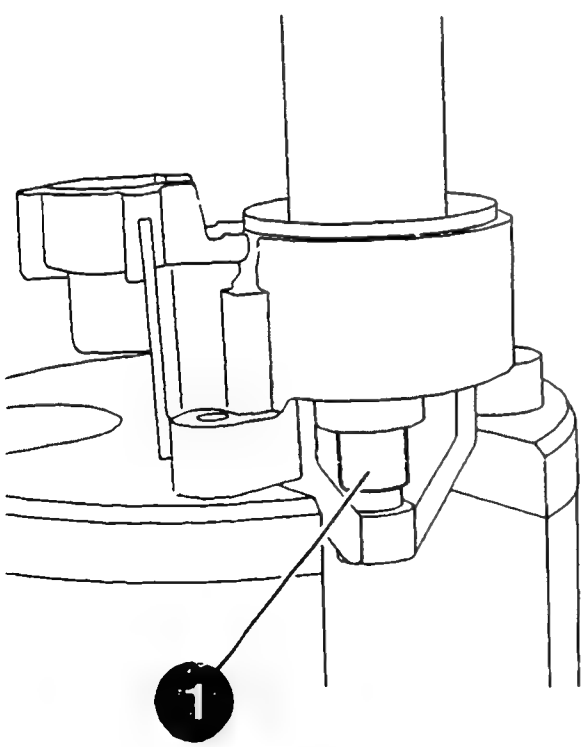
Checking drive-end bearing

Installation: Use pressing-in mandrel (1) to carefully press home new needle bushing in drive-end bearing from inside.

Mandrel press:	comm. avail.
Pressing-in mandrel:	improvised

Continue: II10/1 Fig.: II13/2

KMS00361



COMPONENT CHECKING AND REPAIR

Checking commutator end shield

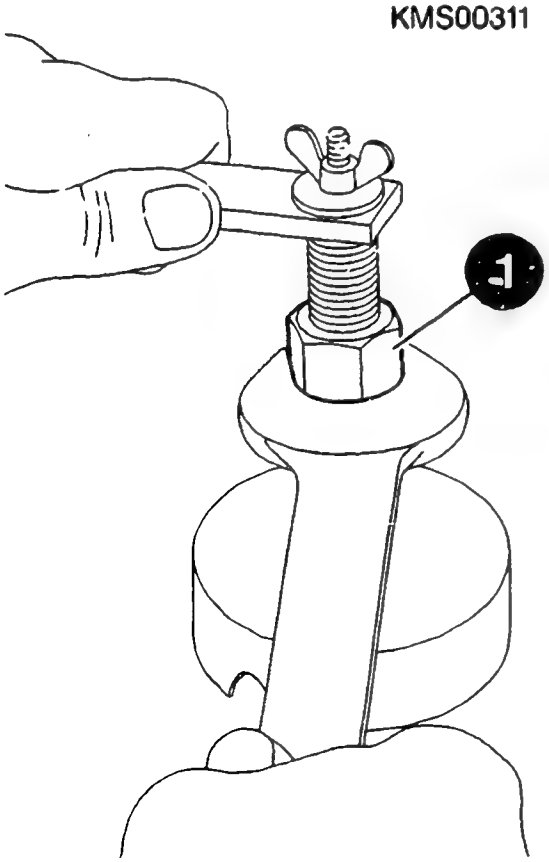
Bushing of commutator end shield is always to be replaced.

Removal: Use puller (1) and spring collet to pull bushing out of commutator end shield.

Puller:	0 986 617 243
Spring collet diameter 10 mm:	0 986 617 250

Continue: II15/1 Fig.: II14/2

KMS00311



COMPONENT CHECKING AND REPAIR

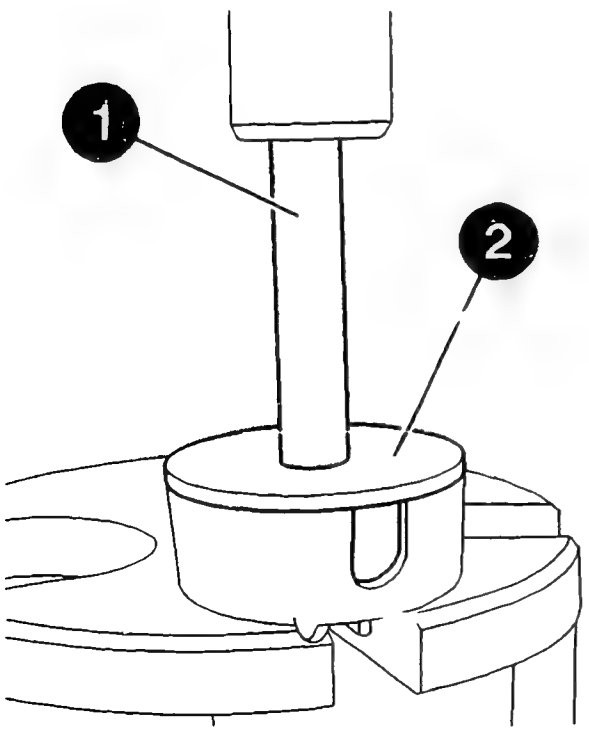
Checking commutator end shield

Installation: Press new bushing with pressing-in mandrel (1) and locating sleeve (2) into commutator end shield from inside.
Make sure locating sleeve (2) is properly positioned in commutator end shield.
ATTENTION: Moisten new bushing beforehand with suitable oil.

Mandrel press:	comm. avail.
Pressing-in mandrel:	0 986 617 149
Locating collar:	0 986 617 212
Oil VS 13 834-01:	5 962 260 000

Continue: II10/1 Fig.: II15/2

KMS00362



COMPONENT CHECKING AND REPAIR

Replacing overrunning-clutch drive

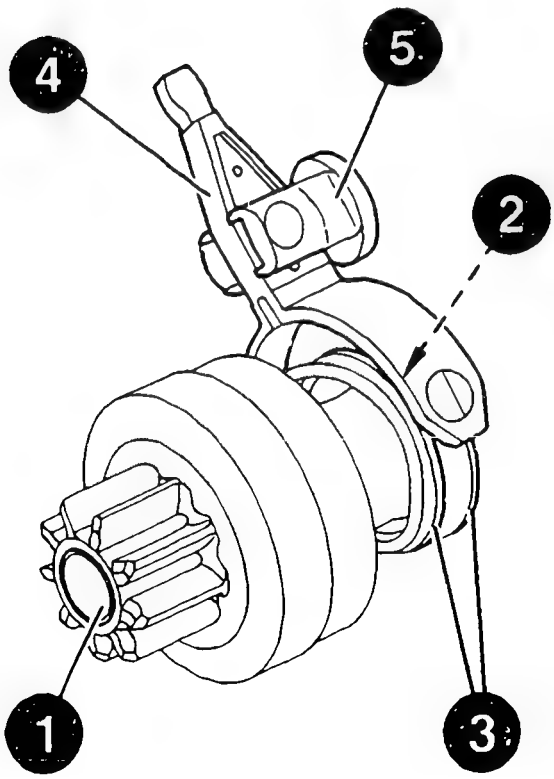
Pinion, bushings (1), spiral spline (2) and driver edges (3) of overrunning-clutch drive are subject to a high degree of wear.

The overrunning-clutch drive is thus always to be replaced.

Also replace fork lever (4) and bearing pedestal (5) of fork lever.

Continue: II17/1 Fig.: II16/2

KMS00486



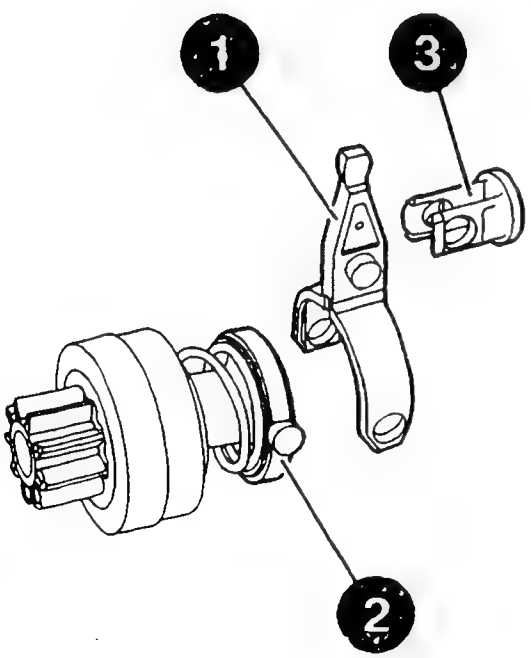
COMPONENT CHECKING AND REPAIR

Replacing overrunning-clutch drive

Engage new fork lever (1) at driver (2) at overrunning-clutch drive.
Engage new bearing pedestal (3) at fork lever with open side facing pinion.
NOTE: Fig. shows disassembled fork lever and bearing pedestal.

Continue: II10/1 Fig.: II17/2

KMS00314



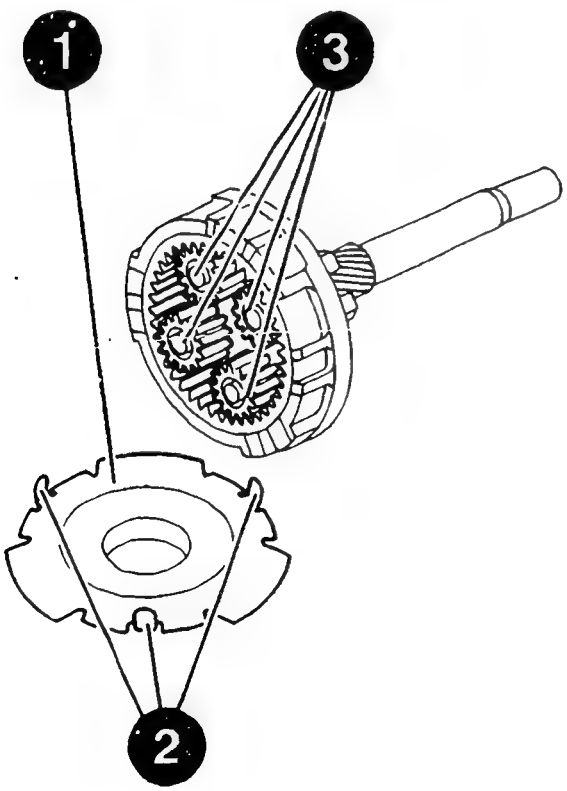
COMPONENT CHECKING AND REPAIR

Checking planetary gear train

Disassembly:
Detach assembly from stand.
Remove cover (1).
NOTE: Even if retaining lugs (2) have broken off, cover is still functional and can be re-used.
Remove planet gears (3).

Continue: II19/1 Fig.: II18/2

KMS00363



COMPONENT CHECKING AND REPAIR

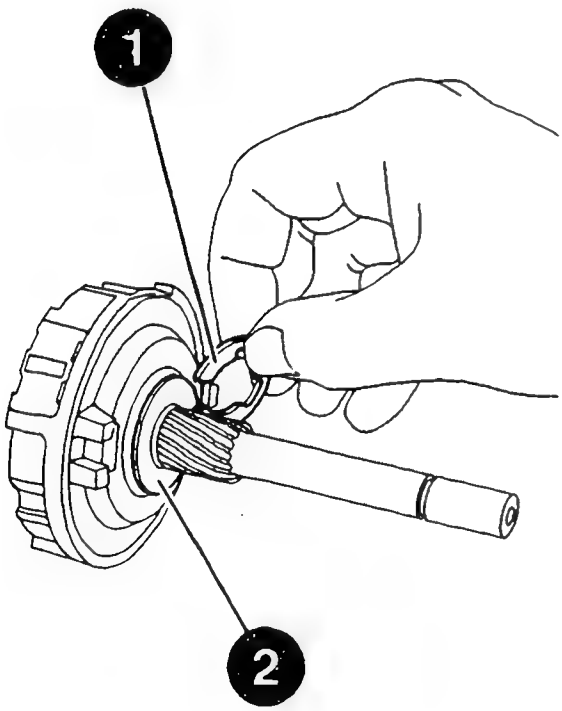
Checking planetary gear train

Further disassembly:
Remove circlip (1).
Detach TX collar (2).

Additionally detach steel collar on type EV 2.6 kW (0 001 223 5..).

Continue: II20/1 Fig.: II19/2

KMS00364



COMPONENT CHECKING AND REPAIR

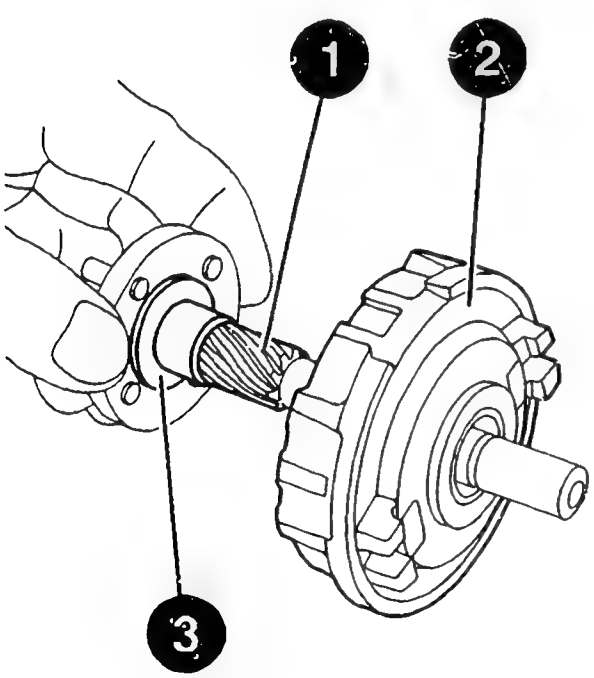
Checking planetary gear train

Further disassembly:

Pull drive shaft (1) out of intermediate bearing (2).
Pay attention to TX collar (3).

Continue: II21/1 Fig.: II20/2

KMS00365



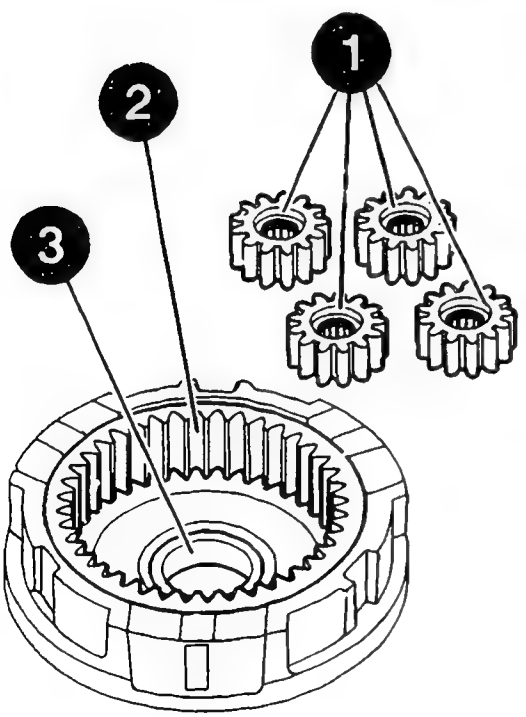
COMPONENT TESTING AND REPAIR

Checking planetary gear train

The complete planetary gear train must be replaced if the planet gears (1), the internal geared wheel (2) or the sun gear bushing (3) are/is worn.

Continue: II22/1 Fig.: II21/2

KMS00366



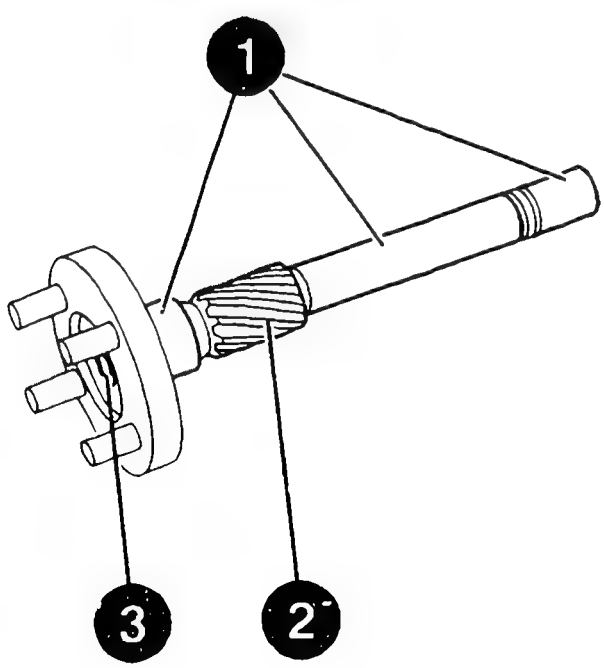
COMPONENT CHECKING AND REPAIR

Checking planetary gear train

If one of the bearing surfaces (1) on the drive shaft or the spiral spline (2) or the sun gear bushing (3) is worn or damaged, then the entire planetary gear train is also to be replaced.

Continue: II23/1 Fig.: II22/2

KMS00367



COMPONENT CHECKING AND REPAIR

Checking planetary gear train

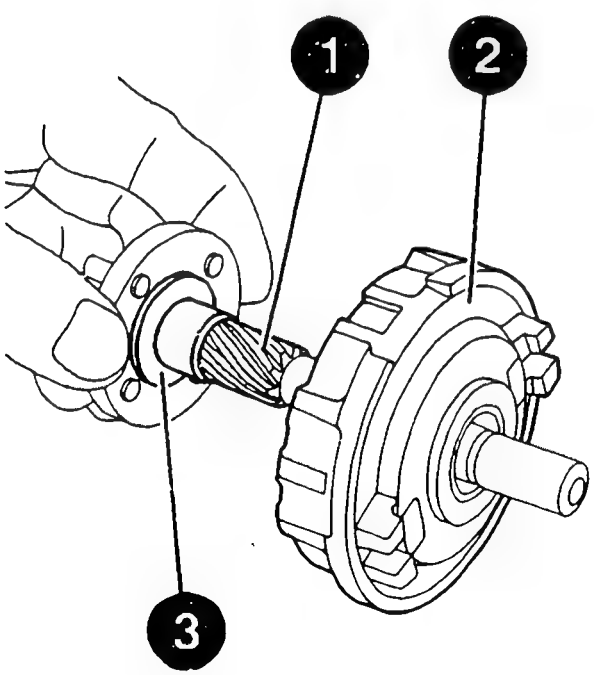
Assembly:
Prior to assembly, clean planetary gear train and remove both carbon brush abrasion and swarf.
Lubricate in line with lubrication schedule during assembly.

Slip TX collar (3) onto drive shaft (1).
Insert drive shaft in intermediate bearing (2).

Grease VS 16069-Ft: 5 984 610 120

Continue: II24/1 Fig.: II23/2

KMS00365



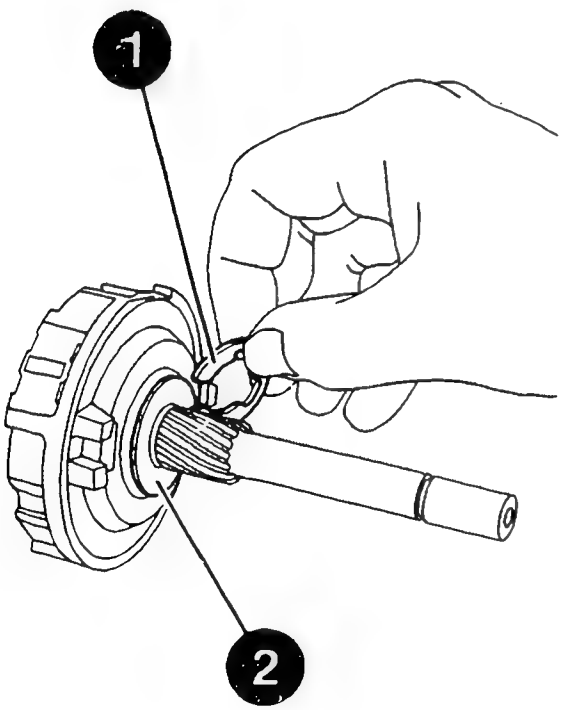
COMPONENT CHECKING AND REPAIR

Checking planetary gear train

Slip TX collar (2) (steel collar as well on type EV 2.6 kW 0 001 223 5..) onto drive shaft.
Fasten circlip (1).

Continue: II25/1 Fig.: II24/2

KMS00364



COMPONENT CHECKING AND REPAIR

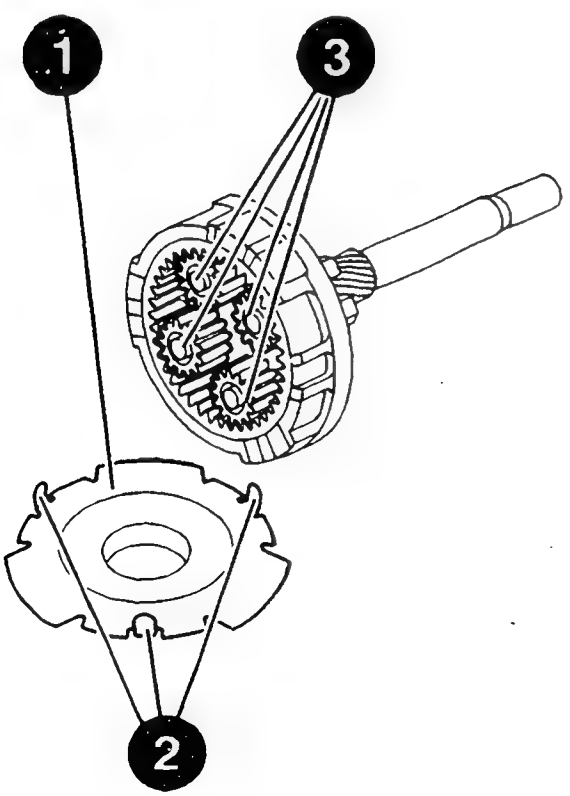
Checking planetary gear train

Further assembly:
Insert planet gears (3) in intermediate bearing.
Fit cover (1), slip planetary gear train onto assembly stand and position vertically.
NOTE: Even if retaining lugs (2) have broken off, cover is still functional and can be re-used.

Assembly stand (reworked): 0 986 617 138

Continue: II10/1 Fig.: II25/2

KMS00363



COMPONENT TESTING AND REPAIR

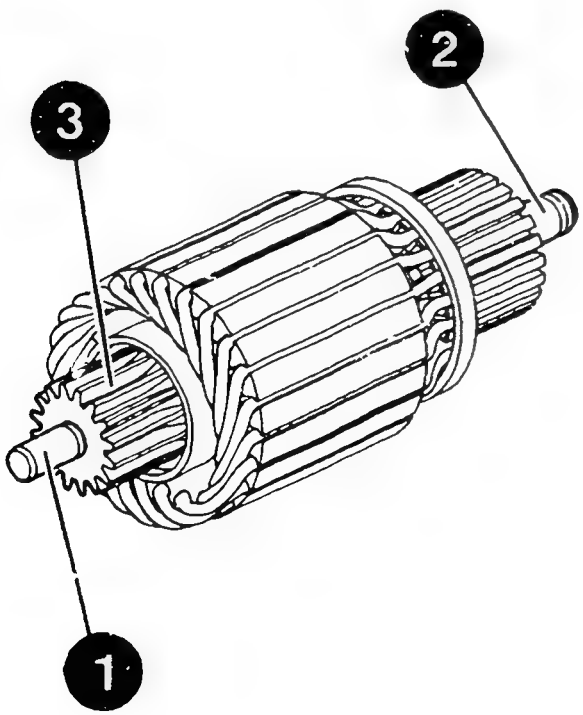
Checking armature

Examine bearing surface of sun gear bushing (1) and commutator end shield (2), as well as sun gear (3) for scoring and damage.

Replace armature if necessary.

Continue: II27/1 Fig.: II26/2

KMS00319



COMPONENT TESTING AND REPAIR

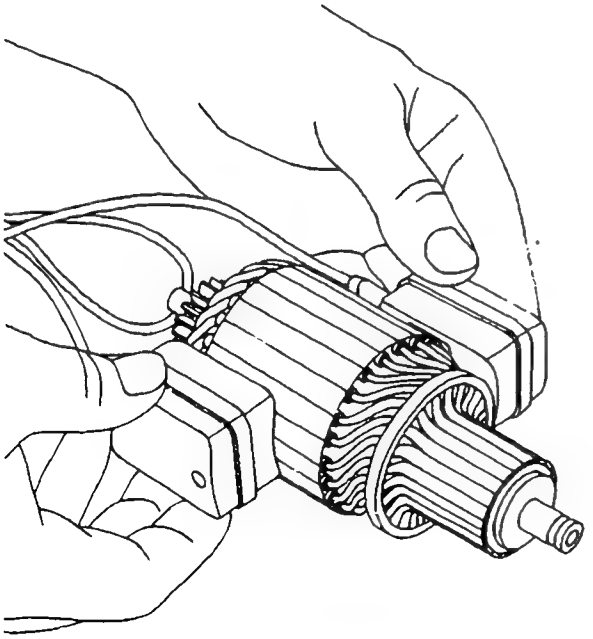
Testing armature

Check armature for interturn short circuit using tester and test probes.

Interturn short-circuit tester with test probes: 0 986 619 110

Continue: II28/1 Fig.: II27/2

KMS00320



COMPONENT CHECKING AND REPAIR

Checking armature

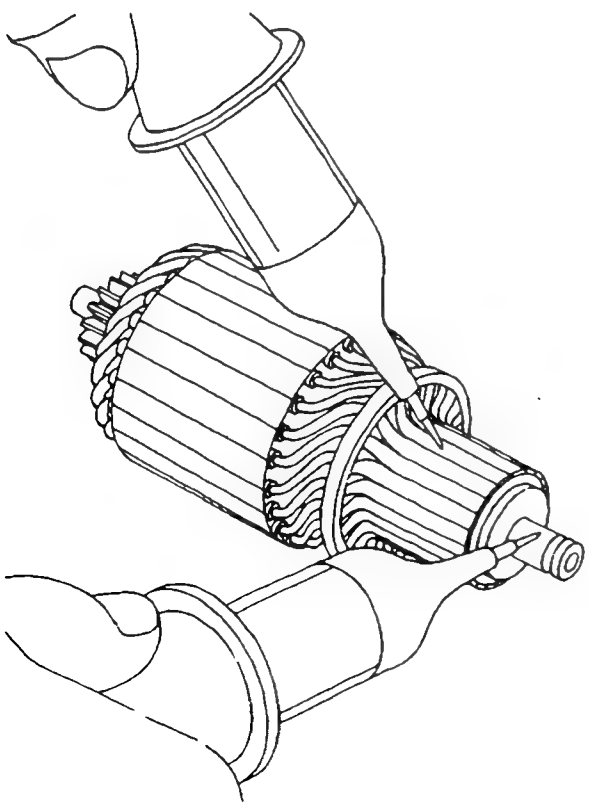
Use tester and test prods to check armature for short to ground and continuity (black laminations are an indication of open circuit).

Interturn short-circuit tester:	0 986 619 110
Test prods:	0 986 619 101
Ground short test voltage:	40 V*
Continuity test voltage:	40 V*

* = AC

Continue: II10/1 Fig.: II28/2

KMS00321



COMPONENT TESTING AND REPAIR

Testing commutator

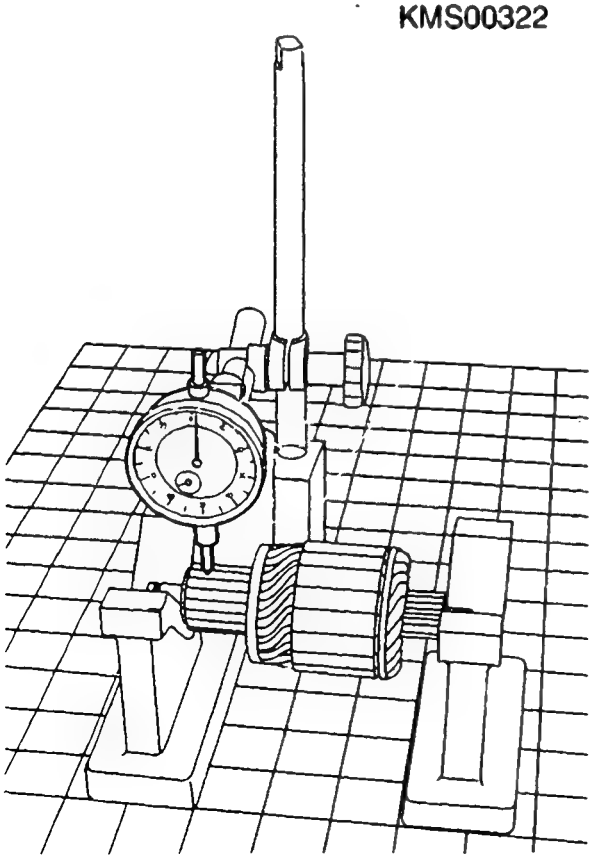
Check commutator concentricity.
If radial run-out is outside stated range, commutator must be turned down.

Magnetic measurement stand:	4 851 601 124
Dial indicator:	1 687 233 011

Radial run-out - Commutator:	< 0,01 mm

Continue: III02/1 Fig.: III01/2

KMS00322



COMPONENT TESTING AND REPAIR

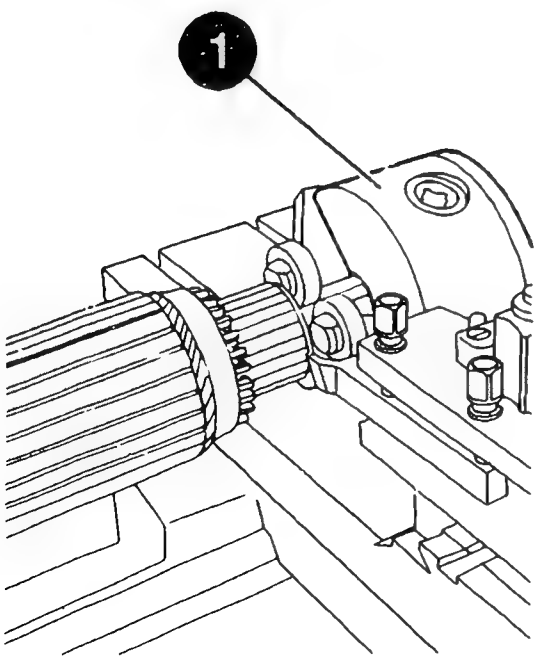
Testing commutator

Turning down involves positioning armature in three-jaw chuck and tailstock rest (1). The max. machining thickness is 0.03 mm.
Pay attention to minimum diameter.

Tailstock rest with Morse taper 2:	0 986 619 156
Mininum diameter:	29 mm

Continue: III03/1 Fig.: III02/2

KMS00193



COMPONENT TESTING AND REPAIR

Checking commutator

After turning down, the commutator segment insulation must be sawn out to a depth of 0.8 mm with a suitable tool.

After sawing out, turn down commutator again and check armature for interturn short circuit and short to ground. Pay attention to diameter.

The carbon-brush wear dimension is also to be checked with turned-down armature.

Continue: III03/2

COMPONENT CHECKING AND REPAIR

Brush holder is to be replaced if necessary.

Interturn short-circuit tester:	0 986 619 110
Minimum diameter:	29 mm
Wear dimension x of carbon brushes:	< 15 mm
Ground short test voltage:	40 V*

* = AC

Continue: II10/1

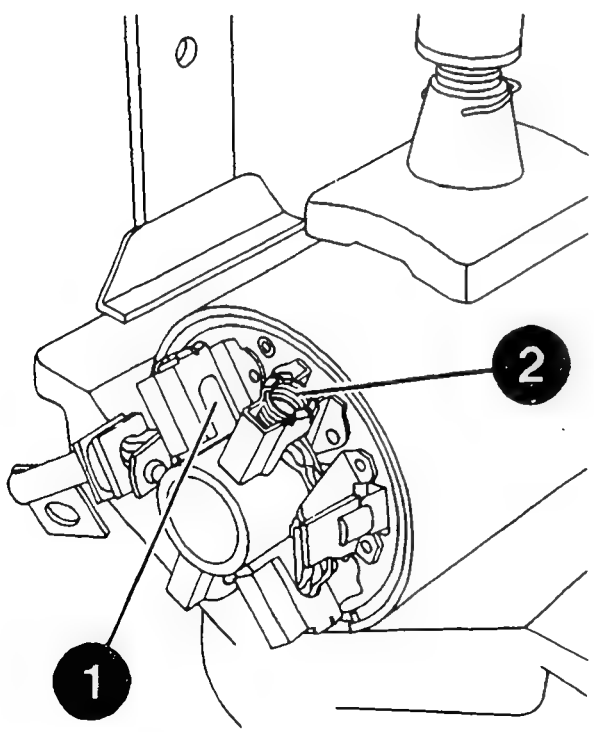
COMPONENT CHECKING AND REPAIR

Checking brush holder

The entire brush holder is to be replaced if the carbon brushes (1) are worn down to their minimum length or damaged or if the helical compression springs (2) are worn. Make exclusive use of parts as per the service parts list applicable to the type of starting motor concerned.

Continue: III05/1 Fig.: III04/2

KMS00368



COMPONENT CHECKING AND REPAIR

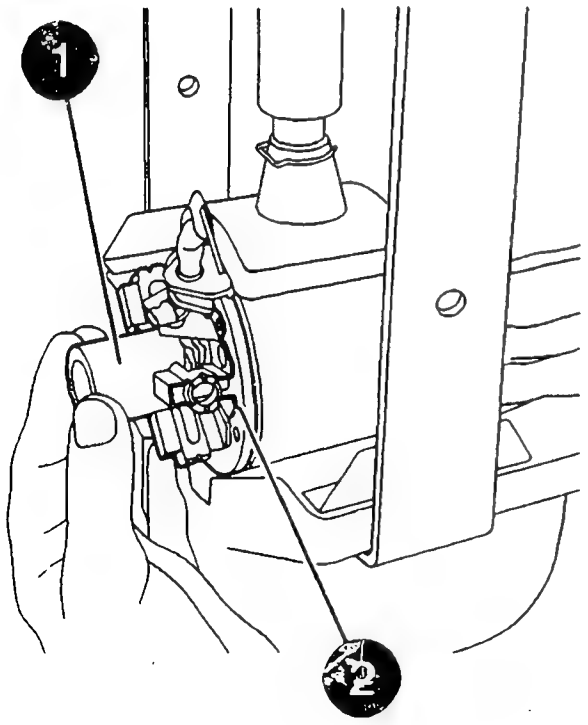
Checking brush holder

Check carbon brush wear.
ATTENTION: Wear dimension is to be checked with armature fitted.
Mount stator frame in clamping support.
Slide armature into stator frame from drive-end bearing side and at the same time pull locating sleeve (1) out of brush holder (2).
ATTENTION: Take care not to damage excitation winding.

Clamping support: 0 986 619 362

Continue: III06/1 Fig.: III05/2

KMS00369



COMPONENT CHECKING AND REPAIR

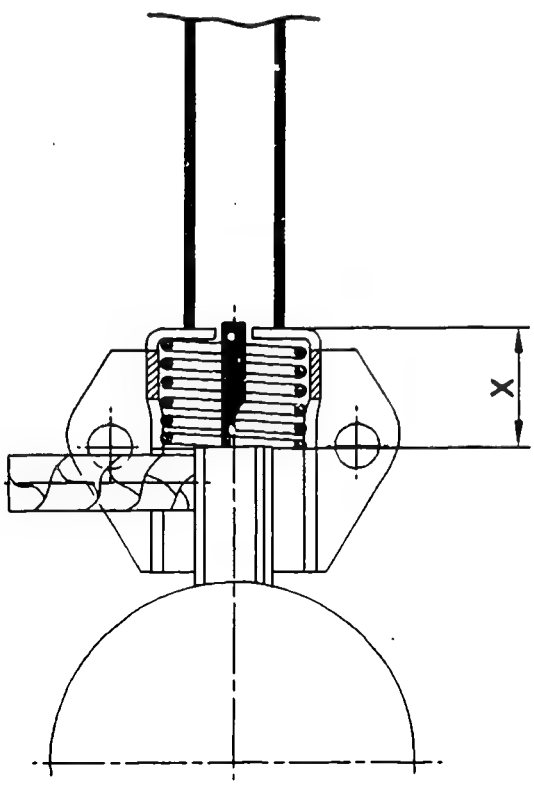
Checking brush holder

Use depth gauge to measure wear dimension x of carbon brushes from top edge of tubular brush holder to top edge of carbon brush.
After testing, slip locating sleeve back onto armature shaft, pull armature out of stator frame towards drive-end bearing side and in doing so insert locating sleeve in brush holder.

Wear dimension x
of carbon brushes: < 15 mm

Continue: II10/1 Fig.: III06/2

KMS00393



COMPONENT CHECKING AND REPAIR

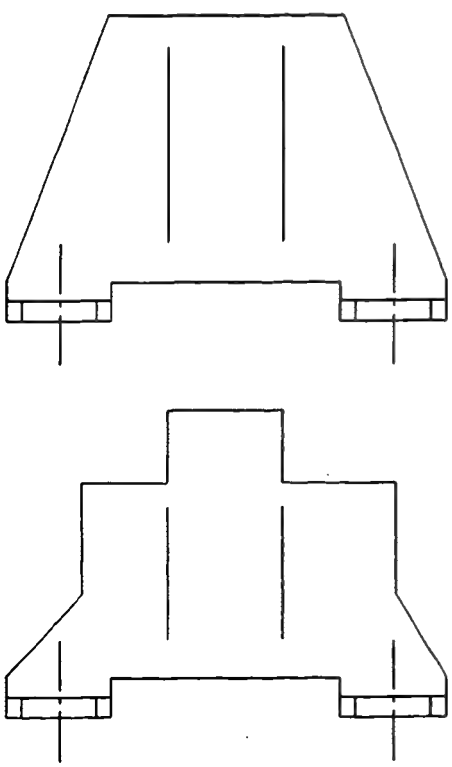
Replacing brush holder

On replacing brush holder, welded joint between connection of excitation winding and brush holder is to be replaced with a bolted joint.

The various brush holder designs differ, for example, in terms of the geometric shape of the bracket for the excitation winding connection. This does not however affect testing and replacement of the brush holder.

Continue: III08/1 Fig.: III07/2

KMS00487



COMPONENT CHECKING AND REPAIR

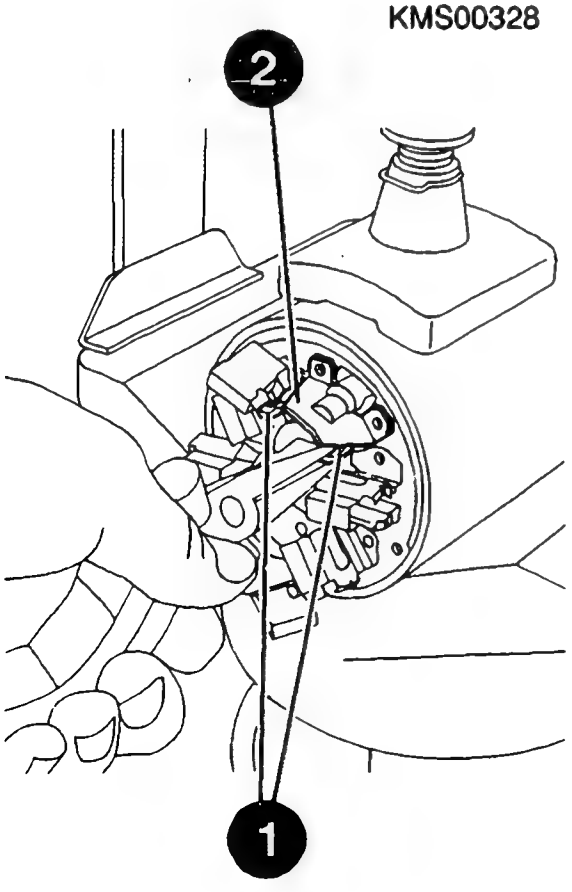
Replacing brush holder

Pull out locating sleeve, pull carbon brushes out of tubular brush holder and remove helical compression springs. Use flat-nose pliers to carefully peel off the welded-on stranded wires (1) of the two carbon brushes at the bracket (2) of the excitation winding connection.

Flat-nose pliers: comm. avail.

Continue: III09/1 Fig.: III08/2

KMS00328



COMPONENT CHECKING AND REPAIR

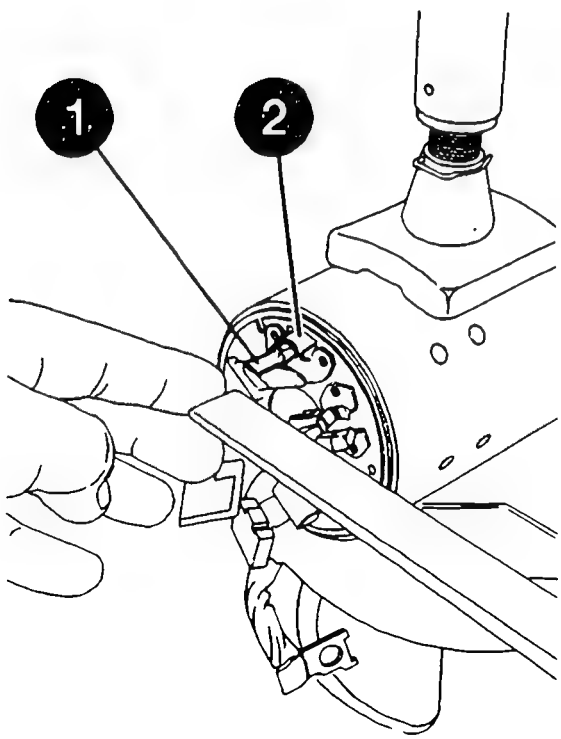
Replacing brush holder

Use flat file to produce a flat resting surface for the bolt head in the solid part of the stranded connecting wire (1).
ATTENTION: Take care not to damage stranded wire and insulation (2).

Flat file: comm. avail.

Continue: III10/1 Fig.: III09/2

KMS00488



COMPONENT CHECKING AND REPAIR

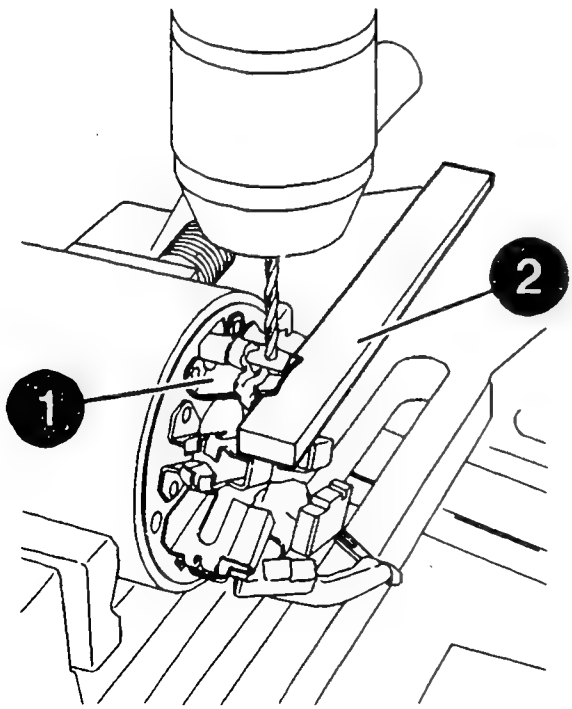
Replacing brush holder

Carefully clamp stator frame in machine vice so as to avoid damaging stator frame. Support bracket (1) with suitable rest (2).

Machine vice: comm. avail.

Continue: III11/1 Fig.: III10/2

KMS00489



COMPONENT CHECKING AND REPAIR

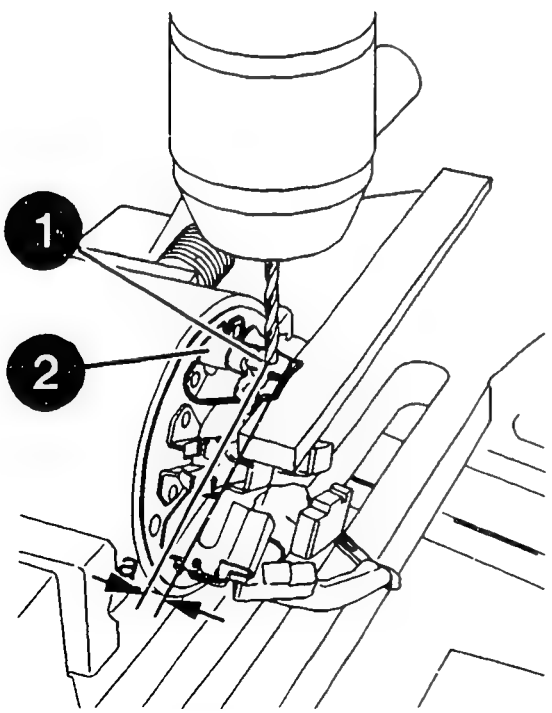
Replacing brush holder

Drill hole of 4,3 mm diameter as centrally as possible in solid part of stranded connecting wire (1) on column drill.
Dimension "a" (between center of hole and top edge of stranded connecting wire) should be at least 3,5 mm.
ATTENTION: Take care not to damage stranded wire and insulation (2).

Column drill:	comm. avail.
HSS drill bit 4,3 mm:	comm. avail.

Continue: III12/1 Fig.: III11/2

KMS00490



COMPONENT CHECKING AND REPAIR

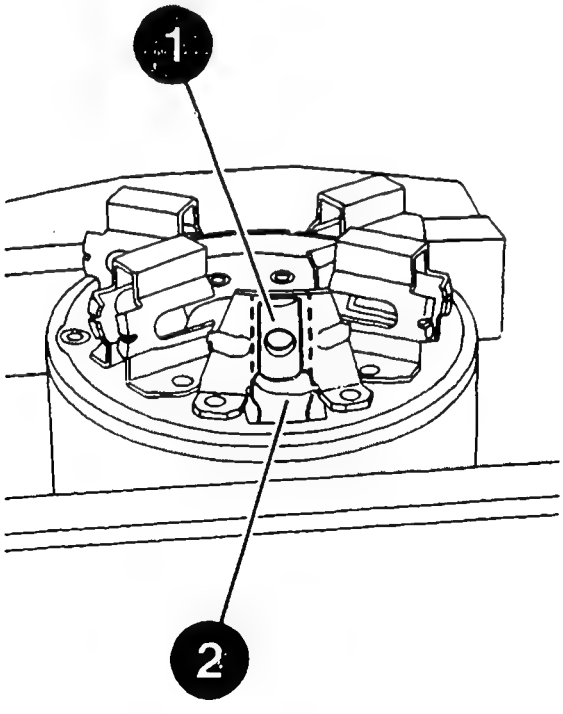
Replacing brush holder

C a r e f u l l y clamp stator frame in vice between soft jaws. Saw (mark, Fig.) into bracket along welded-on stranded wire (1). The two cuts must always be at least 1.5 mm from the edge of the hole.
ATTENTION: Take care not to damage stranded wire and insulation (2).

Hacksaw: comm. avail.

Continue: III13/1 Fig.: III12/2

KMS00329



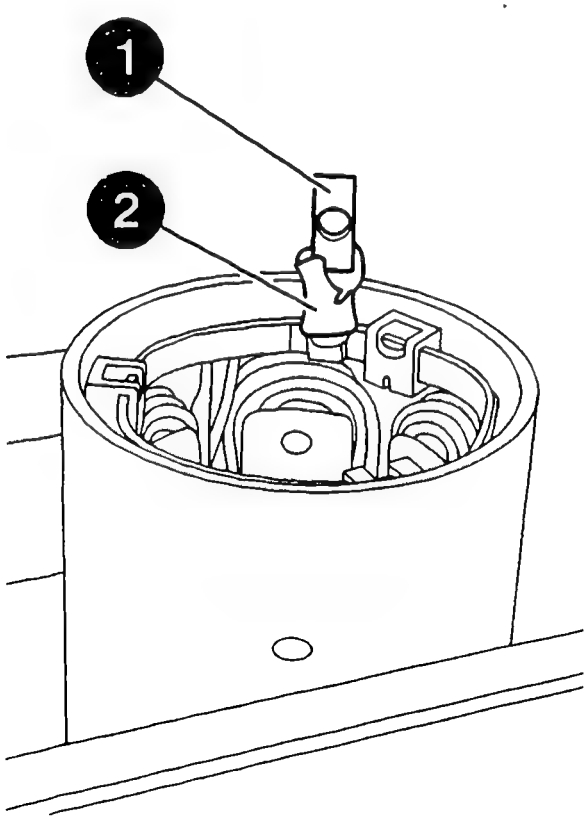
COMPONENT CHECKING AND REPAIR

Replacing brush holder

Detach old brush holder.
Deburr connection (1) of excitation winding and remove welding residue on contact surface.
ATTENTION:
Take care not to damage insulation of stranded connecting wire of excitation winding (2).

Continue: III14/1 Fig.: III13/2

KMS00330



COMPONENT CHECKING AND REPAIR

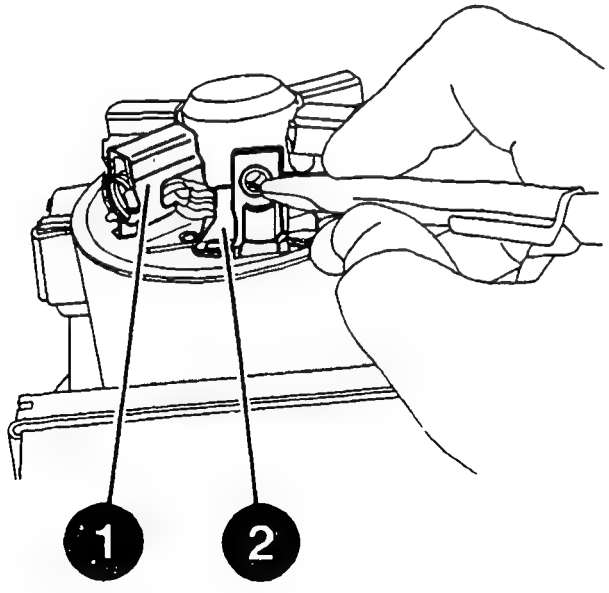
Replacing brush holder

Use three-square scraper to remove residual lacquer from stator frame at brush holder seat.
Insert new brush holder (1) with locating sleeve in stator frame.
Pay attention to correct positioning of locking device.
Place stranded connecting wire (1) on bracket (2) and mark position of hole on bracket (2).

Three-square scraper: comm. avail.

Continue: III15/1 Fig.: III14/2

KMS00491



COMPONENT CHECKING AND REPAIR

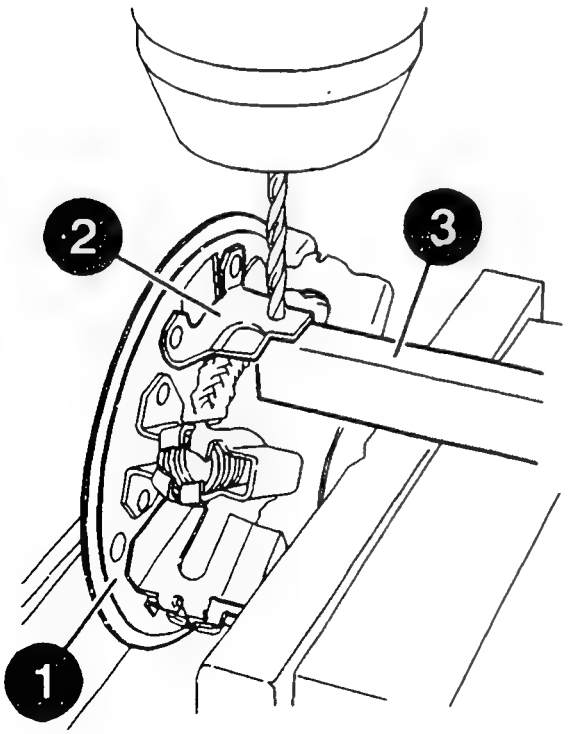
Replacing brush holder

Detach brush holder (1) from stator frame and clamp carefully in machine vice so as to avoid damaging brush holder. Support bracket (2) with suitable rest (3). Drill hole of 4,3 mm diameter in bracket on column drill. Pay attention to mark. Deburr hole.

Machine vice:	comm. avail.
Column drill:	comm. avail.
HSS drill bit 4,3 mm:	comm. avail.

Continue: III16/1 Fig.: III15/2

KMS00492



COMPONENT CHECKING AND REPAIR

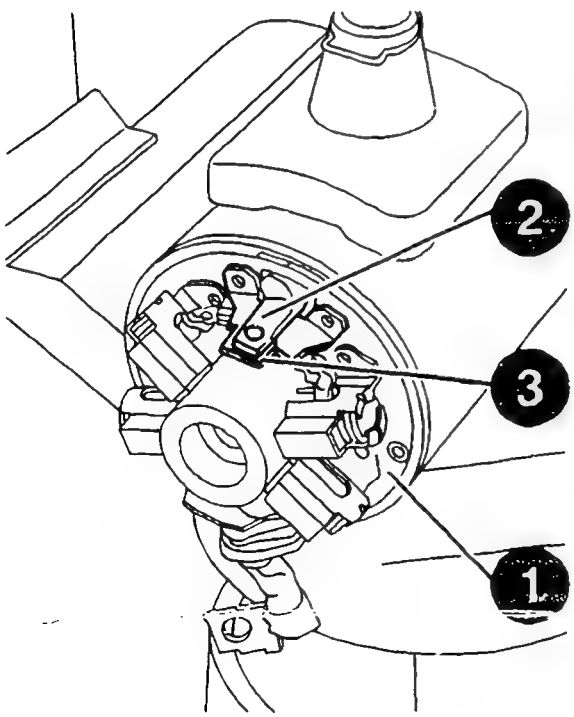
Replacing brush holder

Mount stator frame in clamping support.
Insert brush holder (1) with locating sleeve in stator frame.
Make sure locking device is properly positioned.
Position stranded connecting wire (2) on bracket (3) and align.

Clamping support: 0 986 619 362

Continue: III17/1 Fig.: III16/2

KMS00493



COMPONENT CHECKING AND REPAIR

Replacing brush holder

ATTENTION: DANGER OF SHORT TO GROUND
Make exclusive use of fasteners indicated.
NOTE: Collar must not project over top edge of bracket. Rework if necessary.

Continue: III17/2

COMPONENT CHECKING AND REPAIR

Hexagon bolt M4x6 DIN 933-8.8:	comm. avail.
Spring lock washer DIN 127-B4:	comm. avail.
Hexagon nut B M4 DIN 439-04:	comm. avail.

Continue: III18/1

COMPONENT CHECKING AND REPAIR

Replacing brush holder

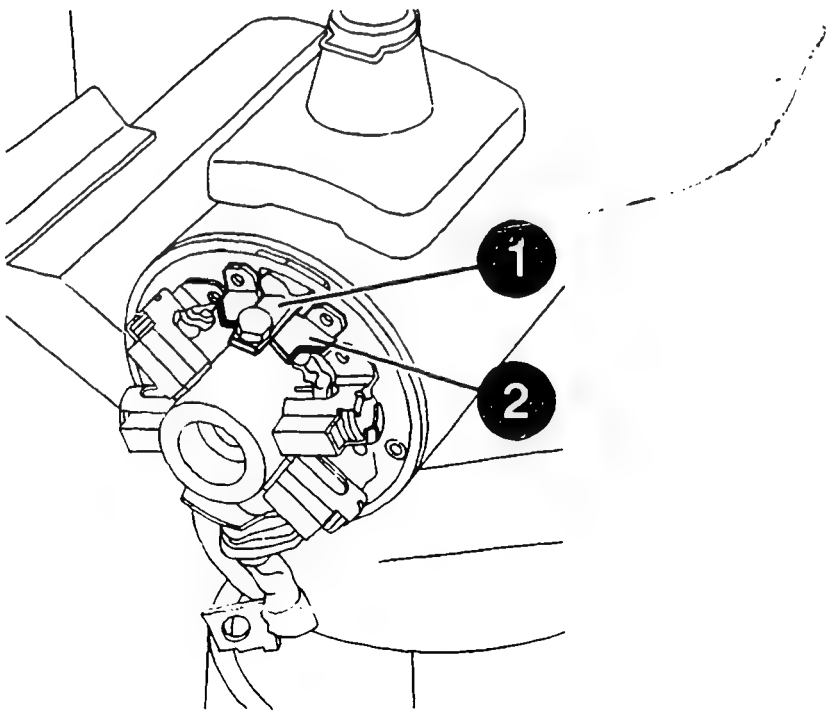
Screw stranded connecting wire (1) to new brush holder.
Stranded connecting wire must make full contact with bracket (2) of brush holder. Rework if necessary.
Use torque wrench.

Torque wrench: comm. avail.

Tightening torque: 3,3...4,1 Nm

Continue: II10/2 Fig.: III18/2

KMS00373



COMPONENT CHECKING AND REPAIR

Checking excitation winding

Use tester and test prods to check winding for continuity between stranded connecting wire (1) and bright part of stator frame.

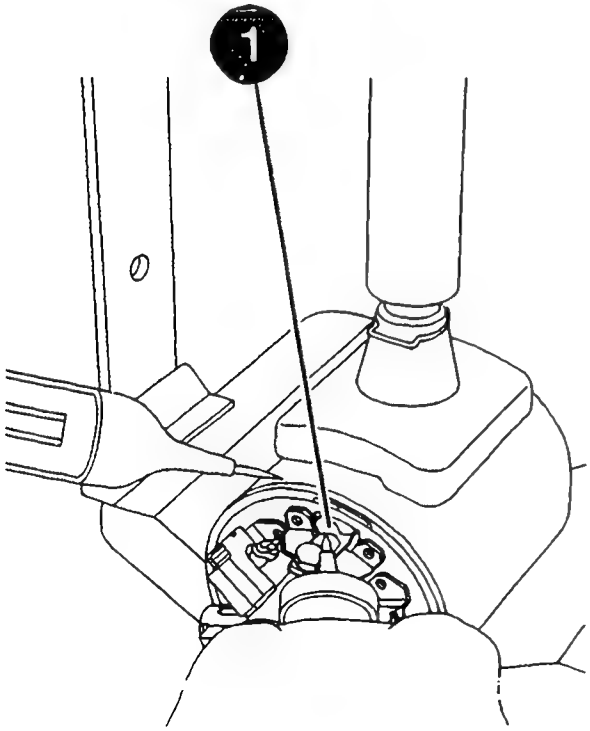
Interturn short-circuit tester:	0 986 619 110
Test prods:	0 986 619 101

Continuity test voltage:	40 V*

* = AC

Continue: III20/1 Fig.: III19/2

KMS00374



COMPONENT CHECKING AND REPAIR

Checking excitation winding

Entire stator frame is to be replaced in the event of defective, scorched, unsoldered or loose windings.

Continue: II10/2

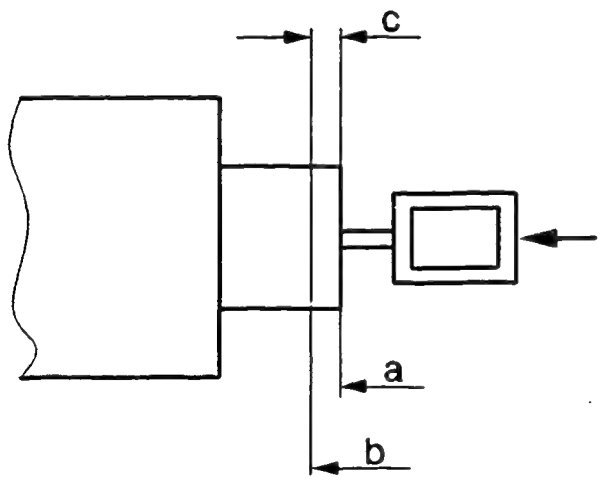
COMPONENT TESTING AND REPAIR

Testing solenoid switch

Examine solenoid switch for damage.
Check burn-off reserve.
Press in armature by hand until current bridge is resting (a) on terminal stud. On pressing in the armature further as far as stop (b) a noticeable increase in force is apparent. The difference between positions (a) and (b) is the burn-off reserve (c). If there is no further burn-off reserve, the solenoid switch must be replaced.

Continue: III22/1 Fig.: III21/2

KMS00375



COMPONENT CHECKING AND REPAIR

Checking solenoid switch

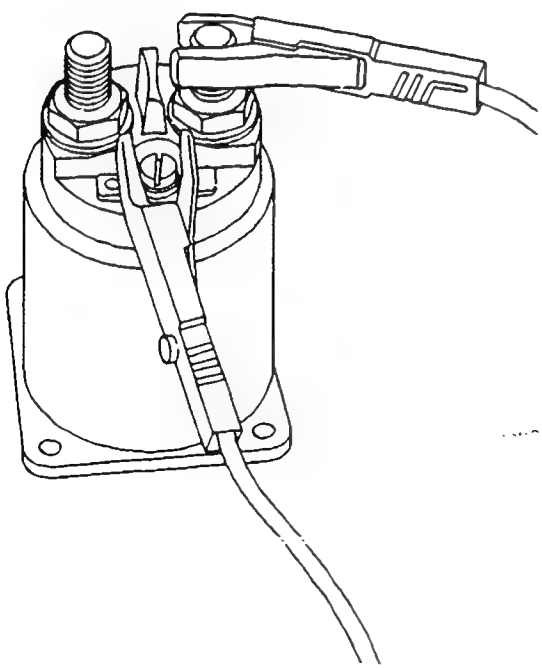
Use tester to check resistance of pull-in winding (term. 50/term. 30-f).

Alternator tester: 0 684 201 200

Pull-in winding resistance
Starting motor - 0 001 223 0..:
0,25...0,30 Ohm
Starting motor - 0 001 223 5..:
0,20...0,25 Ohm

Continue: III23/1 Fig.: III22/2

KMS00239



COMPONENT CHECKING AND REPAIR

Checking solenoid switch

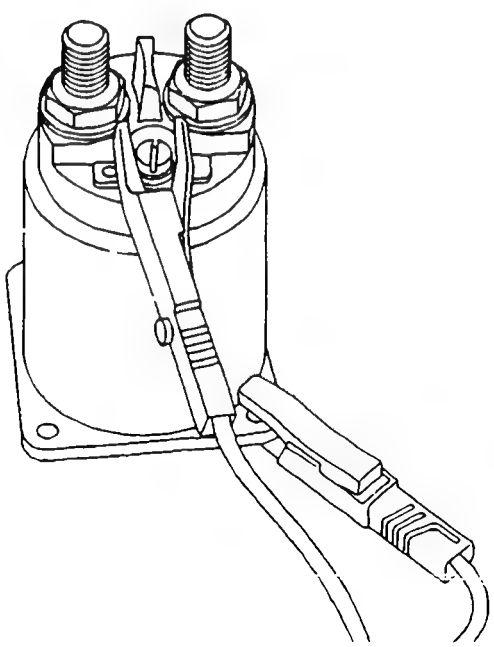
Use tester to check resistance of holding winding (term. 50/ground).

Alternator tester: 0 684 201 200

Holding winding resistance
Starting motor - 0 001 223 0..: 1,1...1,3 Ohm
Starting motor - 0 001 223 5..: 1,0...1,1 Ohm

Continue: III24/1 Fig.: III23/2

KMS00240



COMPONENT TESTING AND REPAIR

Testing solenoid switch

Neither the tests described, nor proper functioning of the solenoid switch when testing the function of the starting motor following repairs can provide reliable information on long-term trouble-free operation of the solenoid switch.
It is therefore advisable to renew the solenoid switch when the starting motor is repaired.

Continue: II10/2

STARTING MOTOR ASSEMBLY TABLE

Assembling overrunning-clutch drive	III26/1
Assembling overrunning-clutch drive and planetary gear train	IV03/1
Assembling armature	IV05/1
Assembling commutator end shield	IV07/1
Assembling drive-end bearing	IV09/1
Checking and adjusting armature axial clearance	IV12/1

Continue: III25/2

STARTING MOTOR ASSEMBLY TABLE

Assembling cap	IV14/1
Checking armature braking torque	IV15/1
Checking overrunning clutch torque	IV18/1
Checking total pinion travel	IV21/1
Assembling solenoid switch	IV22/1
Sealing starting motor	IV25/1

Continue: I01/1

STARTING MOTOR ASSEMBLY

Assembling overrunning-clutch drive

Lubricate in line with lubrication schedule before and during starting motor assembly.

During assembly of overrunning-clutch drive, secure cover of planetary gear train to stop it dropping off.

Continue: III27/1

STARTING MOTOR ASSEMBLY

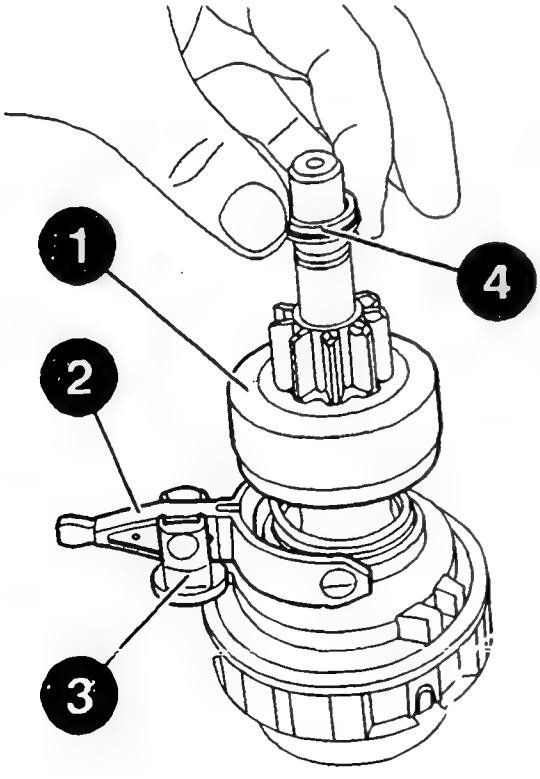
Assembling overrunning-clutch drive

Slip overrunning-clutch drive (1) with fork lever (2) and bearing pedestal (3), as well as new stop ring (4) onto drive shaft.
ATTENTION: Spiral spline of drive must be dry and free of grease to stop drive shaft becoming pasty. Only apply grease to spiral spline on drive shaft.

Grease VS 10832-Ft: 5 932 240 000

Continue: III28/1 Fig.: III27/2

KMS00376



STARTING MOTOR ASSEMBLY

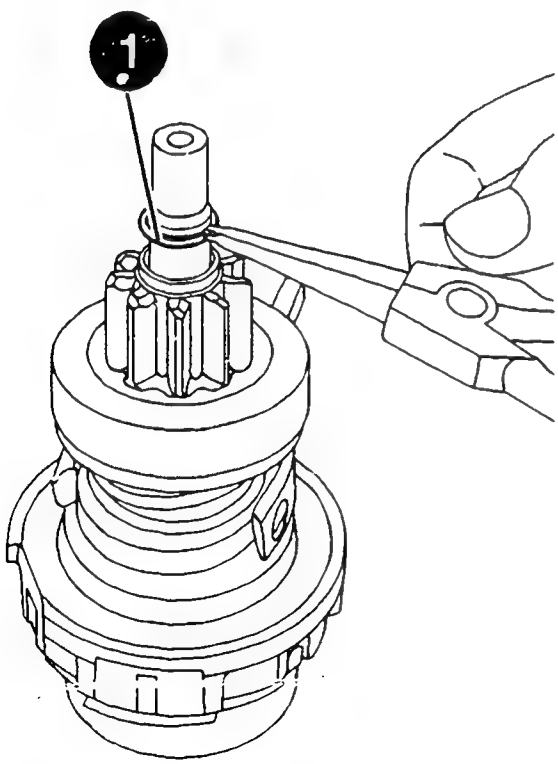
Assembling overrunning-clutch drive

Bend open new circlip (1) with pliers and insert in annular groove.
Use gripping pliers to squeeze circlip together in annular groove.
ATTENTION: Take care not to damage drive shaft when doing so.

Circlip pliers:	comm. avail.
Gripping pliers:	comm. avail.

Continue: IV01/1 Fig.: III28/2

KMS00512



STARTING MOTOR ASSEMBLY

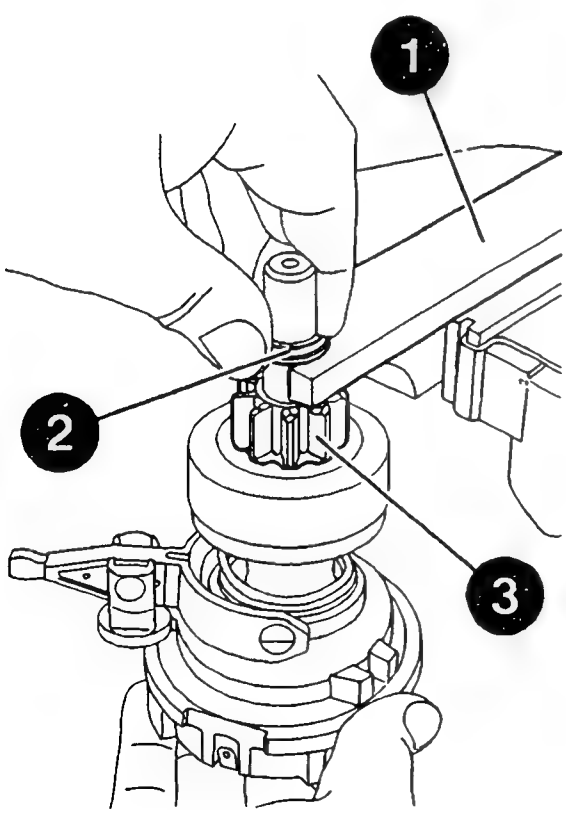
Assembling overrunning-clutch drive

Clamp holder (1) in vice.
Detach planetary gear train with overrunning-clutch drive from assembly stand and insert in holder such that holder is between stop ring (2) and pinion (3).
Pay attention to correct positioning of stop ring in holder.

Holder: 0 986 617 215

Continue: IV02/1 Fig.: IV01/2

KMS00377



STARTING MOTOR ASSEMBLY

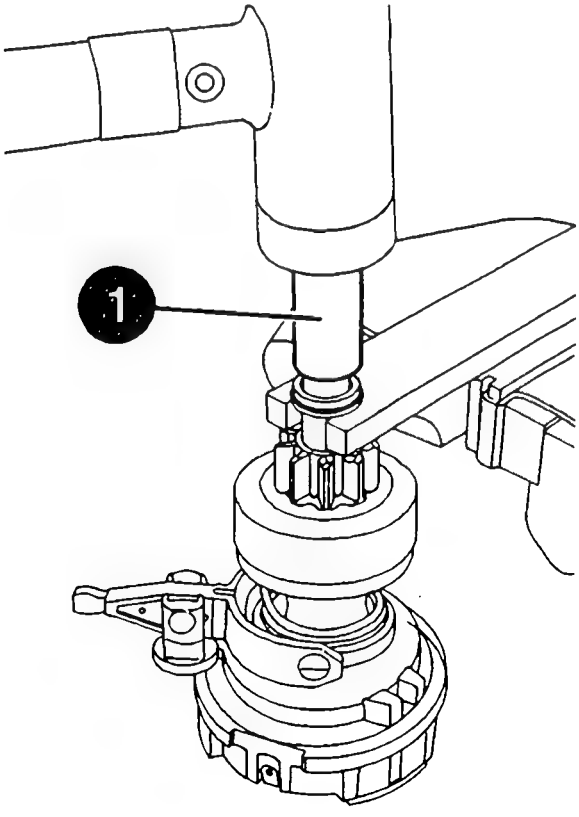
Assembling overrunning-clutch drive

Slip assembly sleeve (1) onto drive shaft such that machined side of sleeve faces circlip. Tap firmly (plastic-headed hammer) on assembly sleeve to engage circlip beneath stop ring. Detach assembly sleeve, remove assembly from holder, slip onto assembly stand and position vertically.

Assembly sleeve:	0 986 617 113
Assembly stand (reworked):	0 986 617 138

Continue: III25/1 Fig.: IV02/2

KMS00378



STARTING MOTOR ASSEMBLY

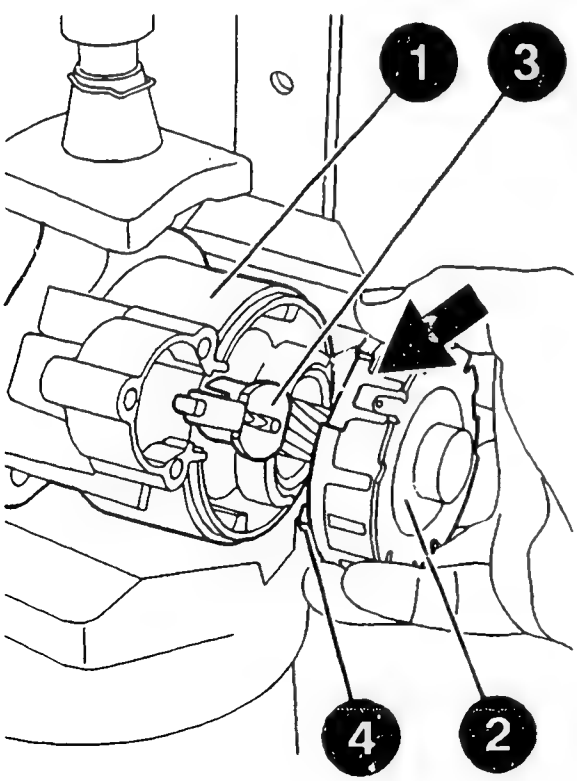
Assembling overrunning-clutch drive and planetary gear train

Mount drive-end bearing (1) in clamping support.
Detach planetary gear train (2) assembly from stand and insert in drive-end bearing.

Clamping support: 0 986 619 362

Continue: IV04/1 Fig.: IV03/2

KMS00379



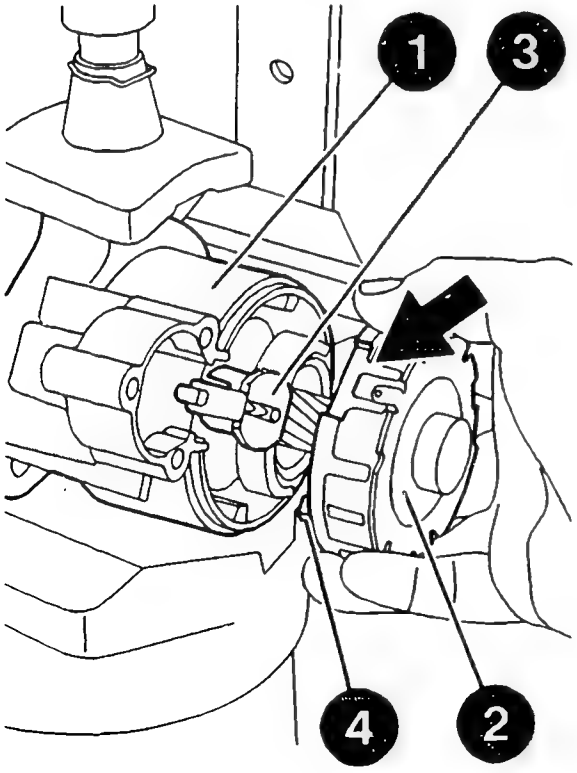
STARTING MOTOR ASSEMBLY

Assembling overrunning-clutch drive and planetary gear train

Insert bearing (3) of fork lever in mount in drive-end bearing.
Fit rubber seal.
Make sure rubber seal is correctly positioned.
Pay attention to correct positioning of locking device (4) of planetary gear train in drive-end bearing.
NOTE: Rubber seal must be located in recess in planetary gear train (see arrow).

Continue: III25/1 Fig.: IV04/2

KMS00379



STARTING MOTOR ASSEMBLY

Assembling armature

Mount stator frame in clamping support. Slip armature into stator frame from drive-end bearing side until armature shaft is positioned in hole in locating sleeve in brush holder.
ATTENTION: Take care not to damage excitation winding.

Clamping support: 0 986 619 362

Continue: IV06/1

STARTING MOTOR ASSEMBLY

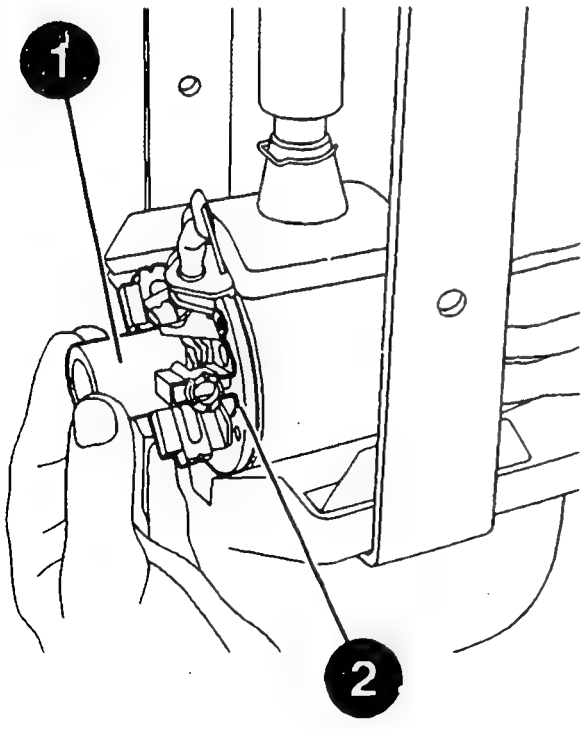
Assembling armature

Push armature further in, whilst at the same time pulling locating sleeve (1) out of brush holder. The carbon brushes must rest on the commutator.
Check brush holder (2) for correct positioning (locking device) in stator frame.

A T T E N T I O N:
Take care not to damage insulation of excitation winding connection.

Continue: III25/1 Fig.: IV06/2

KMS00369



STARTING MOTOR ASSEMBLY

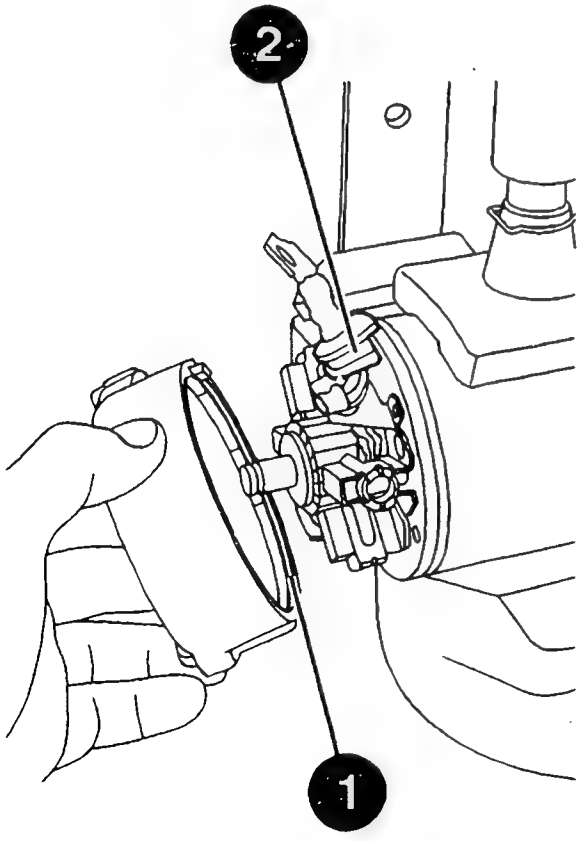
Assembling commutator end shield

Use three-square scraper to clean fitting surfaces at commutator end shield (1) and in stator frame. Mount commutator end shield on stator frame whilst supporting armature from drive-end bearing side. Pay attention to mark. Make sure commutator end shield and rubber seal (2) at connection, term. 30-f are correctly positioned.

Three-square scraper: comm. avail.

Continue: IV08/1 Fig.: IV07/2

KMS00380



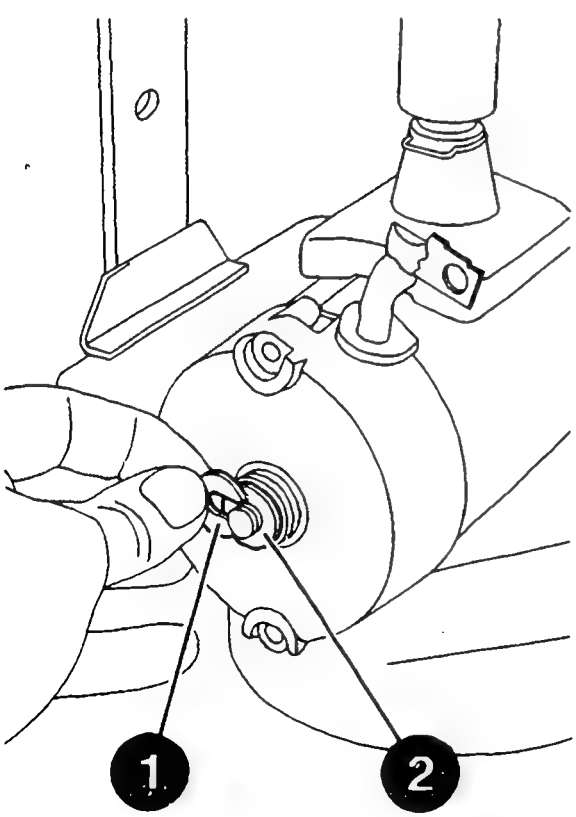
STARTING MOTOR ASSEMBLY

Assembling commutator end shield

Slip new shim (2) onto armature shaft and insert retaining collar (1) in annular groove.

Continue: III25/1 Fig.: IV08/2

KMS00354



STARTING MOTOR ASSEMBLY

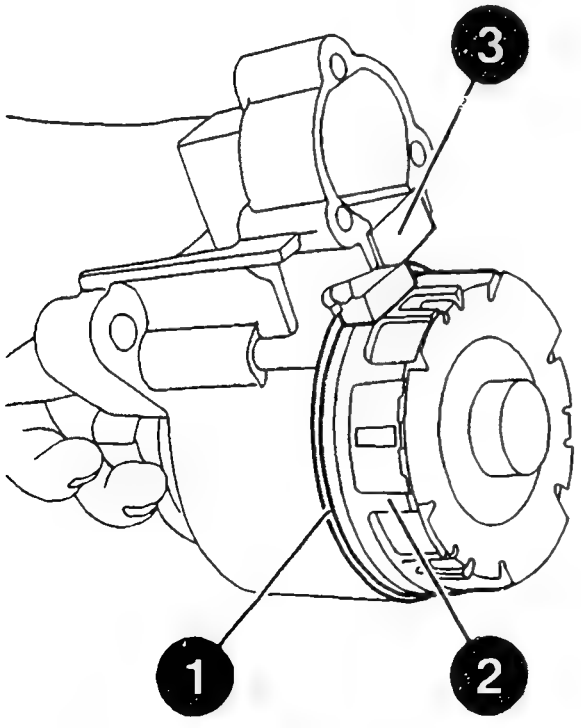
Assembling drive-end bearing

Clean fitting surface (1) at drive-end bearing with three-square scraper. Check correct positioning of planetary gear train (2) and rubber seal (3) in drive-end bearing.

Three-square scraper: comm. avail.

Continue: IV10/1 Fig.: IV09/2

KMS00381



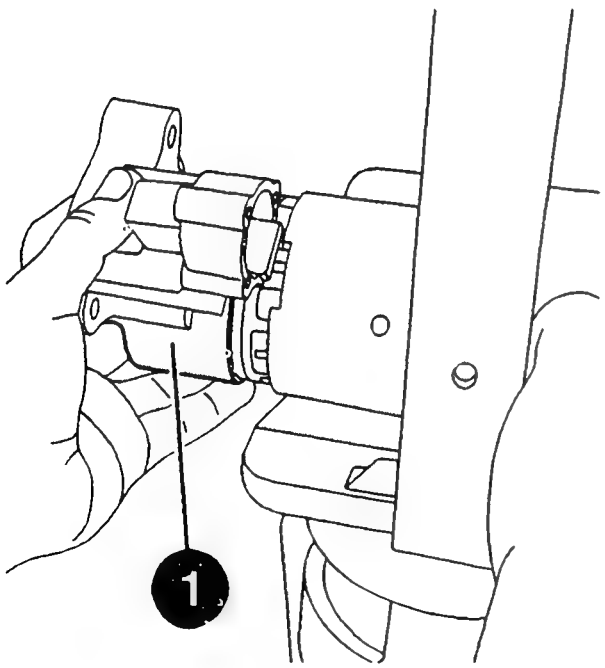
STARTING MOTOR ASSEMBLY

Assembling drive-end bearing

Slide pre-assembled drive-end bearing into stator frame whilst supporting commutator end shield. Slight turning of the entire drive-end bearing unit (1) facilitates meshing of the sun gear of the armature shaft in the planet gears of the planetary gear train.
Pay attention to mark.

Continue: IV11/1 Fig.: IV10/2

KMS00382



STARTING MOTOR ASSEMBLY

Assembling drive-end bearing

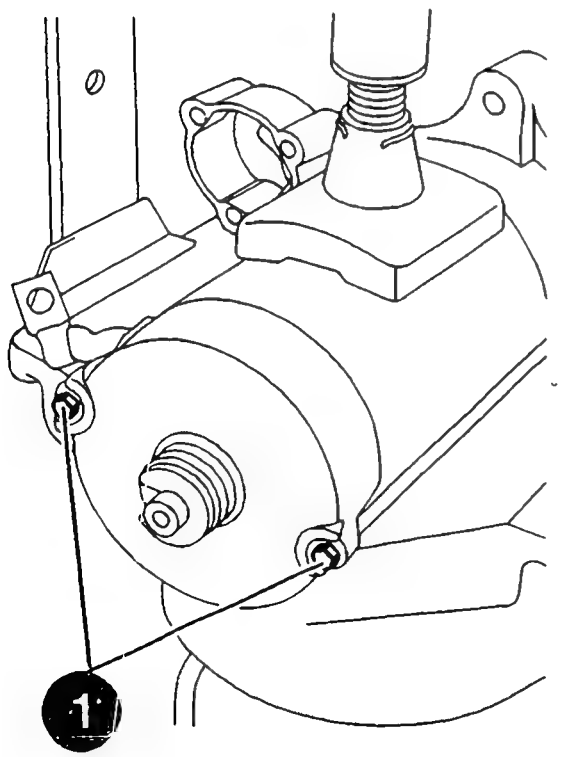
Slacken off clamping support, re-check correct positioning (marks) of drive-end bearing and commutator end shield and secure.
Bolts (1) must run in parallel with imaginary center axis of starting motor and be tightened alternately and evenly.
Use torque wrench.

Torque wrench: comm. avail.

Tightening torque: 5,5...6,0 Nm

Continue: III25/1 Fig.: IV11/2

KMS00383



STARTING MOTOR ASSEMBLY

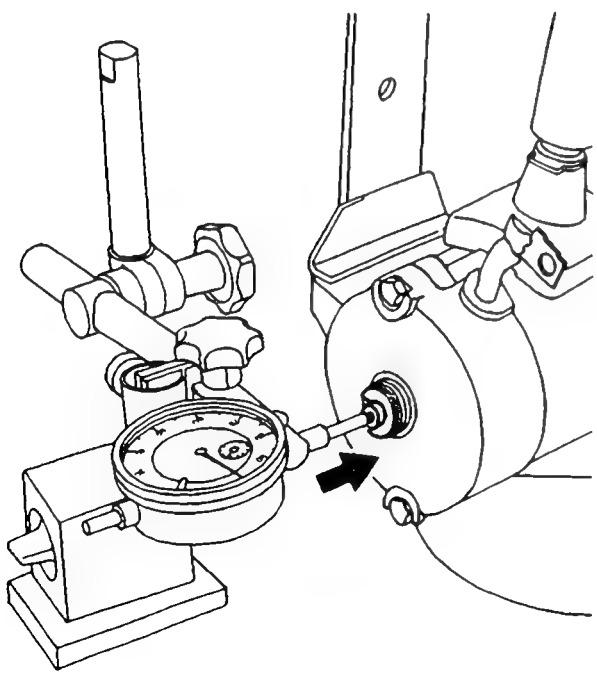
Checking and adjusting armature axial clearance

Slide home armature in direction of drive-end bearing (see arrow).

Appl, dial gauge at end face of armature shaft and set to "ZERO".

Continue: IV13/1 Fig.: IV12/2

KMS00384



STARTING MOTOR ASSEMBLY

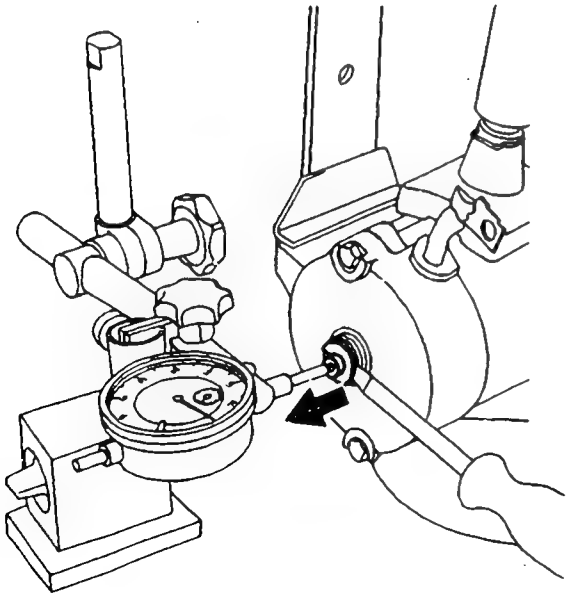
Checking and adjusting armature axial clearance

Move armature in direction of commutator end shield as far as it will go, read off armature axial clearance.
If armature axial clearance is outside stated range, adjustment must be made using an appropriate shim.
Then check armature axial clearance again.
Check freedom of movement of armature.

Armature axial clearance: 0,2...0,8 mm

Continue: III25/1 Fig.: IV13/2

KMS00385



STARTING MOTOR ASSEMBLY

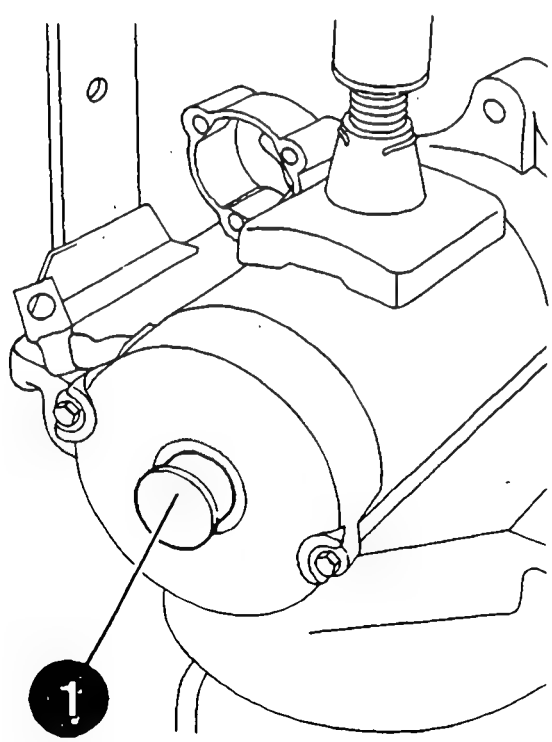
Fitting cap

Fill 1/3 of cap (plastic) (1) with grease and press onto commutator end shield.
Cap can also be fitted by tapping it gently with a plastic-headed hammer.

Grease VS 10832-Ft: 5 932 240 000

Continue: III25/2 Fig.: IV14/2

KMS00386



STARTING MOTOR ASSEMBLY

Checking armature braking torque

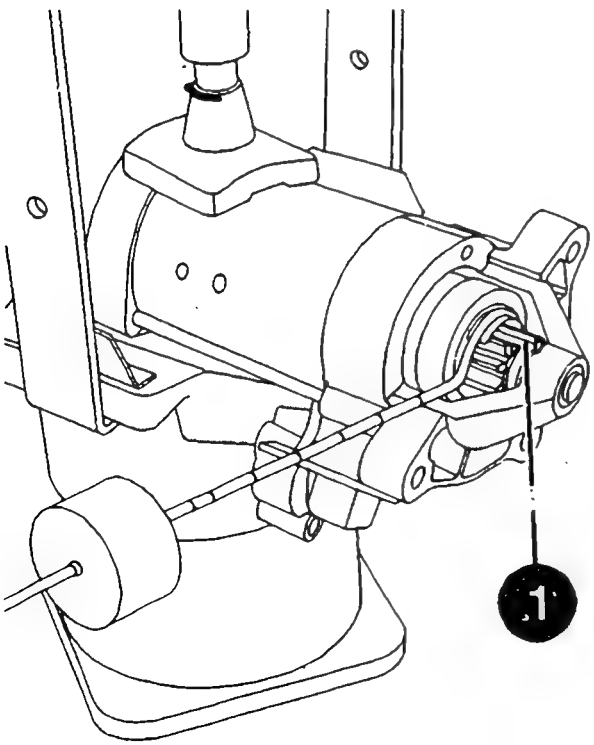
Insert Torx bit socket, for example, in pinion to guarantee (1) correct positioning of torquemeter.
Engage torquemeter at pinion in line with direction of operation of starting motor and move to horizontal position. Shift weight. Pinion may only begin to turn as of mark 8.

Torquemeter: 0 986 617 206

Armature braking torque: 0,8...1,5 Nm

Continue: IV16/1 Fig.: IV15/2

KMS00387



STARTING MOTOR ASSEMBLY

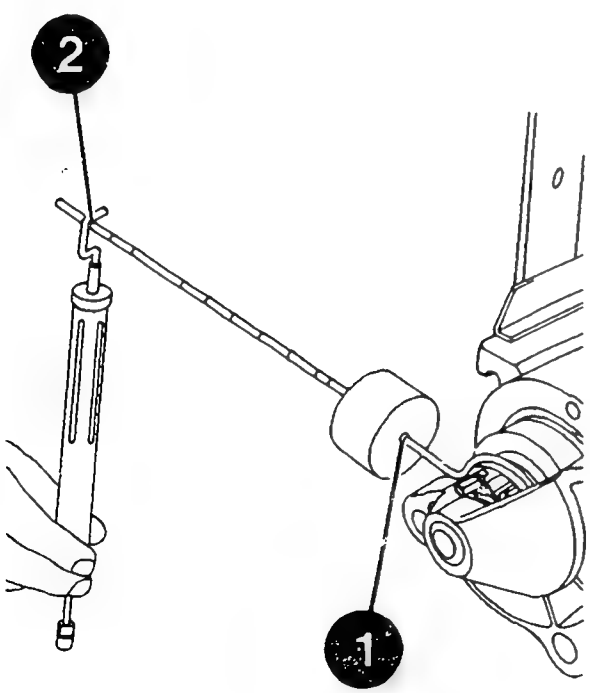
Checking armature braking torque

Proceed as follows if the torque which can be applied with the torque-meter is insufficient to overcome the armature braking torque:
Shift weight to second mark 2.0 (1).
Hook in spring balance at last mark 8 (2).

Spring balance: 0 986 619 181

Continue: IV17/1 Fig.: IV16/2

KMS00388



STARTING MOTOR ASSEMBLY

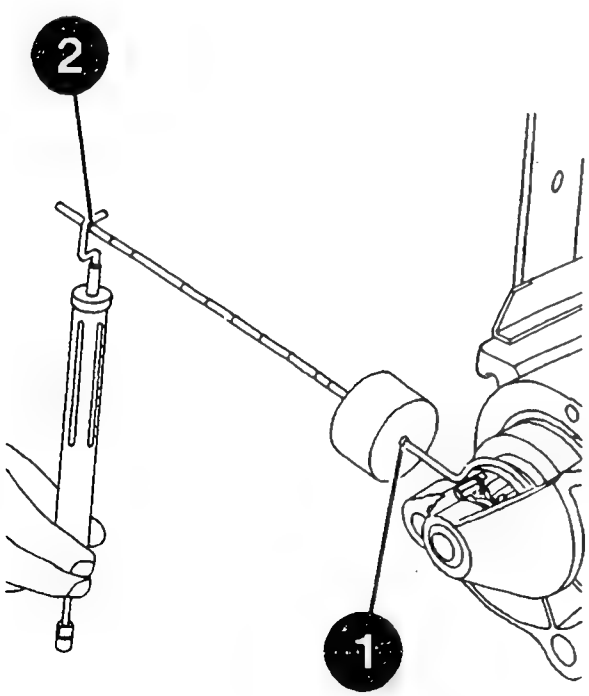
Checking armature braking torque

Pull on spring balance until pinion with armature starts to turn.
Take spring balance scale reading.
Reading may be max. 0,45 kg.
The armature braking torque is then within the required range.
If this is not the case, check components and their assembly.

Armature braking torque: 0,8...1,5 Nm

Continue: III25/2 Fig.: IV17/2

KMS00388



STARTING MOTOR ASSEMBLY

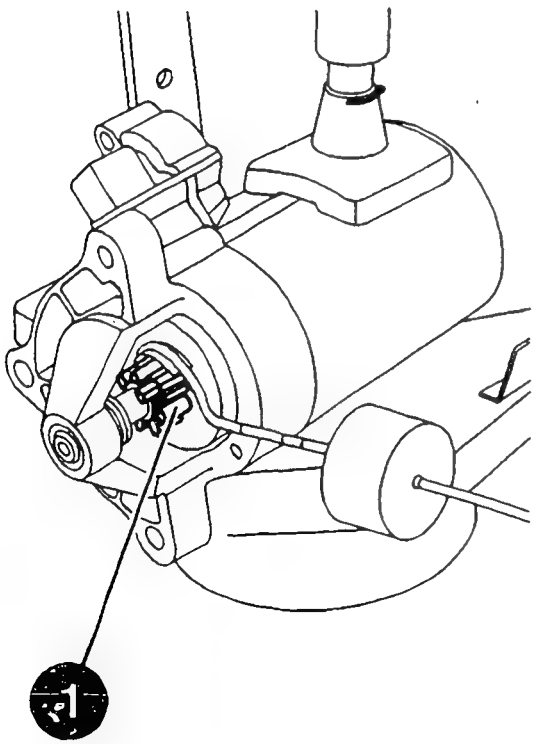
Checking overrunning clutch torque

Insert Torx bit socket, for example, in pinion to guarantee (1) proper positioning of torquemeter.
Engage torquemeter at pinion in line with direction of operation of starting motor and move to horizontal position.

Torquemeter: 0 986 617 206

Continue: IV19/1 Fig.: IV18/2

KMS00389



STARTING MOTOR ASSEMBLY

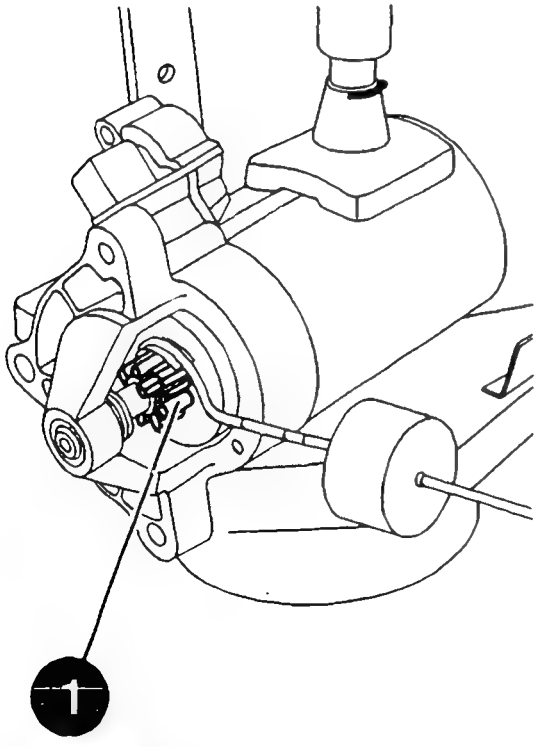
Checking overrunning clutch torque

Shift weight until pinion starts to turn. Note down scale reading and compare to scale value for corresponding type of starting motor in following table.

ATTENTION: Torquemeter must not make contact with drive-end bearing during test.

Continue: IV20/1 Fig.: IV19/2

KMS00389



STARTING MOTOR ASSEMBLY

Checking overrunning clutch torque

Test specification table:

PART NO.	OVERR. TORQUE	SCALE VALUE
.. 223 001:	0,42...0,50 Nm	4,0...5,0
.. 223 002:	0,42...0,50 Nm	4,0...5,0
.. 223 003:	0,27...0,35 Nm	2,8...3,5
.. 223 004:	0,27...0,35 Nm	2,8...3,5
.. 223 005:	0,14...0,22 Nm	1,5...2,0
.. 223 5..:	0,35...0,65 Nm	3,5...6,5

Continue: III25/2

STARTING MOTOR ASSEMBLY

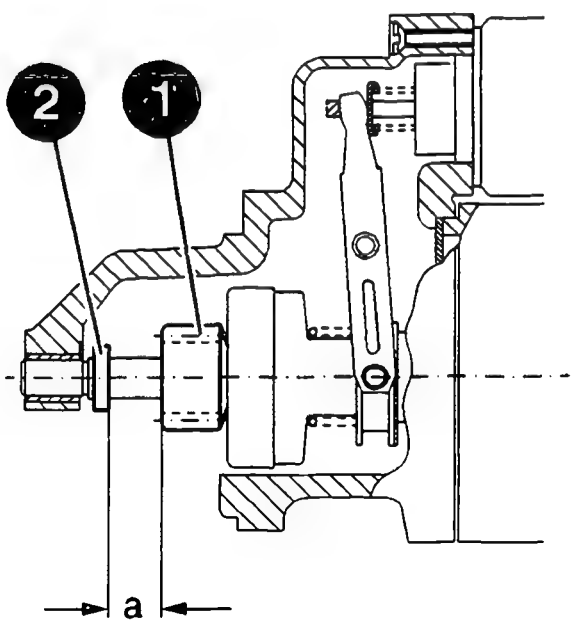
Checking total pinion travel

Measure meshing travel between pinion (1) (at rest) and stop ring (2).

Total pinion travel a
Depending on version: 10,5...15 mm

Continue: III25/2 Fig.: IV21/2

KMS00288



STARTING MOTOR ASSEMBLY

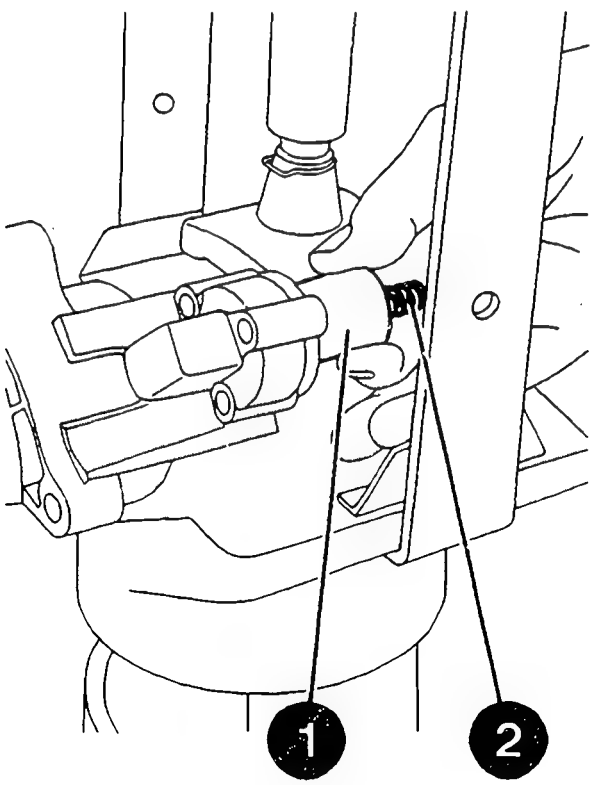
Assembling solenoid switch

Press pinion against stop ring, hook relay armature (1) into engaging lever and grease slightly around periphery. Pay attention to return spring (2) in relay armature.

Gleitmo 1580 V: 5 996 328 000

Continue: IV23/1 Fig.: IV22/2

KMS00350



STARTING MOTOR ASSEMBLY

Assembling solenoid switch

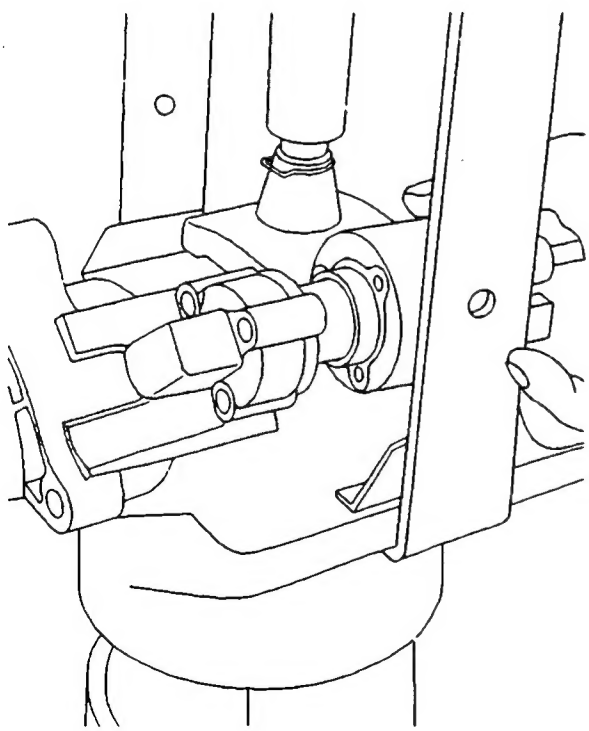
Slip on solenoid switch and attach to drive-end bearing.
Pay attention to mark.
Use torque wrench.

Torque wrench: comm. avail.

Tightening torque: 4,5...5,5 Nm

Continue: IV24/1 Fig.: IV23/2

KMS00349



STARTING MOTOR ASSEMBLY

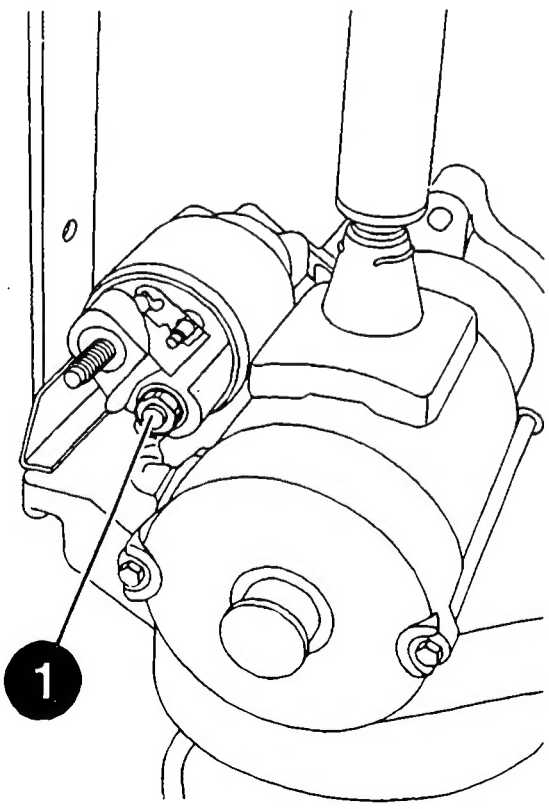
Assembling solenoid switch

Attach connection of brush holder (1) to solenoid switch.
Use torque wrench.

Torque wrench:	comm. avail.
Tightening torque term. 30-f:	7,0...9,0 Nm

Continue: III25/2 Fig.: IV24/2

KMS00347



STARTING MOTOR ASSEMBLY

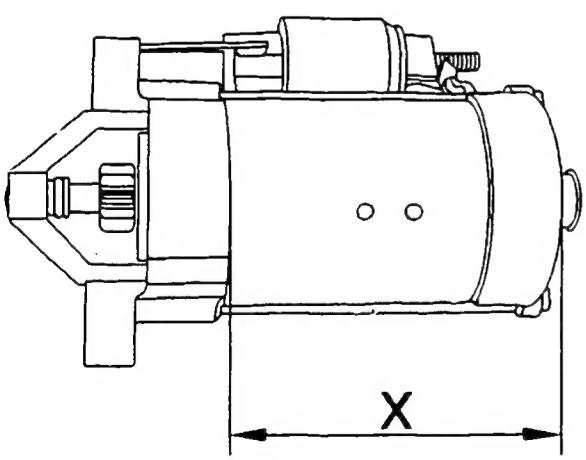
Sealing starting motor

Starting motor must be sealed following assembly.
This involves liberally applying nitrocellulose combination lacquer to starting motor in marked area (x) as shown.

Nitrocellulose combination lacquer
Ft 58 v 3: 5 899 607 017

Continue: III25/2 Fig.: IV25/2

KMS00390



EDITORIAL NOTE

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Continue: IV26/2

EDITORIAL NOTE

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Continue: I01/1